TEXAS COASTAL BASINS

COOPERATIVE RIVER BASIN SURVEY

BY

THE UNITED STATES DEPARTMENT OF AGRICULTURE
IN COOPERATION WITH
THE TEXAS WATER DEVELOPMENT BOARD
THE TEXAS STATE SOIL AND WATER CONSERVATION BOARD
INTERAGENCY COUNCIL ON NATURAL RESOURCES AND THE ENVIRONMENT
THE TEXAS WATER RIGHTS COMMISSION

SEPTEMBER 1977

TEXAS COASTAL BASINS

MAIN REPORT

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September 1977

TEXAS COASTAL BASINS

WATER AND RELATED LAND RESOURCES

MAIN REPORT

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SUMMARY

TEXAS COASTAL BASINS

CHAPTER 1

SUMMARY

PURPOSE

The purpose of the Texas Coastal Basins study is to describe U. S. Department of Agriculture (USDA) program opportunities and impacts for use in facilitating the coordinated and orderly conservation, development, utilization, and management of the water and related land resources of the basin. Achievement of this purpose required an assessment of the water and related land resource problems, needs and development potentials of the basin.

The Texas State Soil and Water Conservation Board, the Texas Water Development Board, the Texas Water Rights Commission, and the Interagency Council on Natural Resources and the Environment, in cooperation with other State and Federal agencies, are continuing long-range programs to obtain water and land resource data. This information can be used to effectively administer and assist in planning water management and land use in Texas.

The U. S. Department of Agriculture needs information about opportunities for development of water and related land use as a basis for assisting local organizations in the development of those resources under the provisions of the Watershed Protection and Flood Prevention Act as well as other USDA programs.

AUTHORITY

The U. S. Department of Agriculture participated in this study under authority of Section 6 of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566, as amended).

BASIN DESCRIPTION

The Texas Coastal Basins are located entirely within the State of Texas and includes all of 24 counties and portions of 22 additional counties.

The study area is about 380 miles long and 70 miles wide and includes about 20,733,400 acres of land and 1,577,500 acres of water bodies over 40 acres in size, most of which is salt water in the bays and estuaries. It is characterized by the low topographic relief which is typical of the entire Gulf Coastal Plain. Elevations range from sea level to about 900 feet.

About 20 percent of the total area of the basin is cropland, 32 percent is range, 20 percent is forest, 12 percent is pasture, and 16 percent is in miscellaneous use such as urban, roads, railroads, farm headquarters, water, Federal lands, etc.

The climate is humid to semiarid. Average annual rainfall ranges from 26 inches at Kingsville to 55 inches at Beaumont. Occasional hurricanes originate at sea and cross into the area from the Gulf of Mexico.

The underlying geological formations range in age from Recent on the coast to Oligocene in the interior and consist mostly of poorly consolidated sand and clay.

The area includes portions of six land resource areas:

Gulf Coast Prairie	- 41 percent
Gulf Coast Marsh	- 2 percent
Blackland Prairie	- 5 percent
Rio Grande Plain	- 28 percent
Southern Coastal Plain	- 16 percent
Texas Claypan Area	- 8 percent

The dominant soils are dark-colored clay derived from calcareous clay. Alluvial soils border a few of the larger streams. Deep, sandy soils occur on dunes and beaches, and there are narrow strips of marshland along the coast.

Water resources consist mainly of ground water, streams, rivers which cross the area, and bay estuarine areas near the coast.

Vegetation is that typical of forest, range, prairie and marsh, with habitat gradients developed from plant communities which are dynamic and diverse. These interspersed vegetative patterns are greatly influenced by a variety of land use trends and the amount of annual rainfall. Forest lands occur throughout, with commercial forests of pine and hardwood concentrated in the Upper Subarea; a variety of water-tolerant hardwoods along the streams and post oak in the Middle Subarea; and widely scattered live oak-cedar-elm-hackberry type in the Lower Subarea. Rangeland is confined to the more arid Lower and Middle Subareas. Prairies are found in all subareas with the production of rice and grain sorghums being a haven for waterfowl. Marshes are found throughout the coastline. Zones of grasses, both freshwater and salt, are developed relative to sea level elevation.

This area has been a farming and ranching area since the arrival of the white man. Grain sorghum, rice, and cotton are the principal cash crops grown. Livestock production is still important to the economy. Agricultural lands along the coast are rapidly giving way to urban and industrial expansion. Principal cities along the coast are Houston, Galveston, Beaumont, Port Arthur, and Corpus Christi.

Due to the vast reserves of oil, gas, sulfur, and other minerals, and an abundance of power and transportation, the area has grown into a great industrial, shipping, and manufacturing center. At the present time the oil and petro-chemical industry contribute more to the area economy than agriculture. Forestry, tourism, and commercial fishing are significant to the area economy.

The population of the study area was 3.2 million in 1970. The basin population is increasing at a rate faster than the State as a whole or the rest of the Nation.

In 1960, urban population was 2,066,853 and amounted to 80.8 percent of the total population for the study area. Typical of the dramatic population shifts, urban population increased 52.0 percent between 1950 and 1960 while total population increased 36.1 percent. Rural population decreased 5.5 percent during this period. By 1970 urban population was approximately 2,898,400 or 82 percent of total population. While the rural population portion declined at a lower rate in the 1960's, actual rural population increased by over 14 percent. Urban population increased twice as fast.

Based on the Water Resources Council's projections for water resource planning regions, projected 2020 population for the Texas Coastal Basins is 4.9 million or 150 percent of the 1970 population. The projected United States 2020 population is estimated at 140 percent of the 1970 population. The Texas Water Development Board anticipates a Texas Coastal Basins increase of 270 percent, mostly in the upper portion of the basin.

PROBLEMS AND OBJECTIVES

Flooding is a major problem in the basin. Most damages are sustained by the agricultural sector - crops, pastures, and on-farm fixed improvements. There are 7,296,500 acres of land subject to flooding. The total annual damages are estimated at $66,660,000.

Agricultural drainage is a problem since many acres of crops and pasture are on soils with excess water. Excess water is a problem on 5,581,600 acres of land. Of this, cropland totals 2,584,300 acres and pastureland totals 1,931,800 acres. Damage to forest land is considered insignificant. The problem of inadequate drainage on flatlands is considered inseparable from problems of flooding.

The improper use of agricultural land is magnified by limitations associated with inherent soil properties and unfavorable climatic conditions. Over 18 million acres of agricultural land has a primary limitation in use of either erosion, wetness, shallow root zone or insufficient rainfall. These hazards affect about 4 million acres of cropland, 7 million acres of rangeland, 2 million acres of pastureland, 4 million acres of forest land, and .6 million acres in other uses.

Forest production losses occur from fire, insect and disease which reduce growth or cause mortality. Southern pine beetle damage was considerable during the last 15 years. About three-fourths of the State's pine beetle damage is located within the basin.

The magnitude of the erosion problem in the basin can best be expressed in acres of land lost or damaged and tons of sediment delivered annually. In the Texas Coastal Basins study area, 68 acres of land are lost to gully erosion, 133 acres to streambank erosion, and 109 acres to shoreline erosion annually. Scouring by floodwater damages about 11,100 acres of flood plain annually and overbank deposition of sediment on the flood plain damages 29,400 acres annually.

Sheet erosion supplies 6,670,400 tons of sediment annually to the bays and estuaries from sources within the basin. Gully, streambank, and roadside erosion furnish an additional 2,220,700 tons annually and shoreline erosion yields 1,021,000 tons of sediment annually to the bays and estuaries. The amount of sediment delivered to the bays and estuaries annually from sources within the basin is 9,912,000 tons and 17,219,400 tons from outside the basin for a total of 27,131,400 tons.

Recreational problems were determined and based on the demand and supply of water, land, and facilities for selected recreation activities. These activities include swimming, picnicking, water skiing, boating, hiking, and camping. The demand for swimming, picnicking, camping, and skiing exceeds supply of resources - land, water, and facilities.

Fish and wildlife problems as they relate to fishing and hunting were determined and based on the demand versus supply of habitat and harvestable species. Fishing opportunities are abundant nearby for most basin residents; however, in certain areas these opportunities are inadequate insofar as quantity and quality are concerned.

Resources associated with hunting are adequate to satisfy current demand; however, shortages will occur in future years for specific types of hunting in certain areas.

Environmental problems are considered those relative to enhancement of environmental quality by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. Problems, previously addressed, were determined and quantified to include the interrelationships of environmental factors - improvement of water quality, reduced gully and roadside erosion, reduced sediment damage, reduced agricultural pollution, and enhancement of fish and wildlife habitat. In addition, it is recognized that consideration must be given to the preservation of environmental features - namely, preservation of natural and scenic areas, ecological communities, archeological sites, and historic sites.

The amounts of rainfall and its distribution throughout the year, especially the growing season, has a very definite effect on the need for and use of irrigation. Presently, the total irrigated acreage is about 610,000 acres with about 472,000 acres of rice, 21,000 acres of cotton, and 25,000 acres of grain sorghum being the major crops irrigated.

NEEDS

Needs were identified for the major objectives. These needs reflect the desires as interpreted from study concerns, and are practical and reasonable. However, solutions may be limited by existing authorities and in some cases new legislation may be required. Component needs for specific components and major objectives are summarized in Table 1-1.

USDA PROGRAM OPPORTUNITIES AND MAJOR EFFECTS

Program opportunities are summarized in Table 1-2. Data are presented for the total basin; also, the effects are displayed for the Economic Development, Environmental Quality, and Social Well-Being accounts. Program opportunities - USDA and others - are identified.

Structural measures and facilities proposed for installation in the program by year 2000 are estimated to cost $185,923,400. Land treatment elements total $49,113,000 by year 2000 with an additional $63,951,000 estimated to be established by year 2020.

The average annual costs, consisting of project installation, operation, maintenance, and replacement, is $15,249,700. Average annual benefits from structural measures expected to accrue as the result of flood damage reduction and improved agricultural water management amount to $30,599,700 for an overall primary benefit-cost ratio of 2.0:1.0. Benefits from other components were not evaluated.

TABLE 1-1

Specific Components and Component Needs, Present and Projected

Texas Coastal Basins

Specific Components	Component Needs	Unit 3/	BASIN TOTAL Current	2000	2020
ECONOMIC DEVELOPMENT					
1. Increased Productivity of land for residential, agricultural, commercial, and industrial activities	Flood Reduction:				
	Agriculture	M Acres	4067	3780	3552
	Urban	M Acres	396	390	385
	Sheet erosion damage reduction	M Tons	6670	2102	3411
2. Increased output of outdoor recreation opportunities	Camping	M Activity Days	3776	19040	28653
	Picnicking	M Activity Days	1955	44424	64285
	Swimming	M Activity Days	22536	168652	337274
	Golf	M Activity Days	1127	10378	21598
	Child's Play	M Activity Days	0	15702	56918
	Baseball/Softball	M Activity Days	0	0	1791
	Trails	M Activity Days	34092	340543	740859
	Watersports	M Activity Days	0	3304	18441
3. Increase or more efficient output of timber production	Increased timber production	M Cu. Ft.	0	15000	0
4. Increased hunting & fishing opportunities	Increased pier fishing activities 1/	M Activity Days	215	3602	5856
	Increased hunting activities 2/	M Activity Days	0	0	0
5. Increased agricultural production through irrigation	Provide additional surface water supply for irrigation	M Ac. Ft.	0	524	867
ENVIRONMENTAL QUALITY					
6. Improved quality aspects of water and land					
a. Improved water quality	Overbank deposition	M Acres	39	15	29
	Bays and estuaries	M Tons	27160	6630	12593
b. Reduction in non-point critical erosion	Critical erosion reduction:				
	Gully -	M Tons	526	184	369
		Acres	68	16	44
	Streambank -	M Tons	1187	520	1006
		Acres	133	59	120
	Shoreline -	M Tons	1021	447	805
		Acres	109	47	92
	Scour damage -	Acres	11100	5200	11100
7. Preservation of archeological sites, historical sites	Protection	Number	2678	123	108
		Number	319	78	108

1/ Sufficient water resources exist in the basin for boat fishing.
2/ A need exists in some subareas; however, this need can be met from resources in other subareas as shown in the basin totals.
3/ M = X1000

Source: River Basin Staff, SCS

TABLE 1-2

Summary Display of Elements, Effects and Program Opportunities

Texas Coastal Basins

Element	Economic Development Account Beneficial	Economic Development Account Adverse Effects
	---------- $000	----------
Resource Management Systems for Erosion and Sediment Damage Reduction	---Not Evaluated----	
Floodwater Drainage Reduction and Improved Water Management Systems		
Channel Modification Miles - 2,284	$ 30,257	$ 14,992
Dam FP - 14	342	258
Forest Production Development MCF - 6,300	270	118
Outdoor Recreation Facility Development	1,200	100
	630 1/	
	20,860 2/	
Total	$ 53,559	$ 15,468
Net	$ 38,091	

Environmental Quality Account Beneficial & Adverse Effects	Social Well-Being Account Beneficial & Adverse Effects	Program Opportunities USDA	Program Opportunities Other
1. Terrestrial wildlife habitat will benefit from accelerated land treatment associated with project implementation.	1. Personal income increase direct & external: $77.0 million	1. ACP	1. State Forestry Program
2. Disrupt aquatic ecosystems on 155 miles of natural perennial streams.	2. Employment increased opportunities, direct & external: 2,045 man-years	2. PL 46	2. Corps of Engineers
3. Channelization of the stream right-of-way will destroy 52,350 acres of existing habitat.	3. Stabilizes rural economy & rural living	3. PL-566 Watershed Projects	3. Housing & Urban Development
4. Construct 89 publicly accessible fishery pools on perennial streams.	4. Increased use of natural resources at higher and better uses	4. RC&D Projects	4. Soil & Water Conservation Districts
5. Revegetation of stream right-of-way with selected multi-purpose flora to enhance wildlife.	5. Economic advantage not predominantly in the area of greatest need	5. USFS-State	5. Drainage Districts
6. Reduction of wintering water-fowl habitat and aquatic nursery areas by increased drainage		6. FHA Loans	6. Texas Parks and Wildlife Department
7. Create 1,038 surface acres of aquatic habitat.		7. Flood Hazard Studies	7. Bureau of Outdoor Recreation
8. Inundate 1,038 surface acres of medium terrestrial habitat.			8. U. S. Geological Survey
9. Protect 13,600 acres of bottom-land habitat by eliminating flooding below FP structures.			
10. Destroy 207 acres of wetlands.			
11. Install 57 water level gates to enhance the management of the remaining wetlands.			

1/ Utilization of labor resources in project construction

2/ Value of output to users indirectly associated

CHAPTER 2

INTRODUCTION

TEXAS COASTAL BASINS

CHAPTER 2

INTRODUCTION

This report presents the results of a study of water, land, and related resource problems and needs in the Texas Coastal Basins. The Type IV cooperative river basin study was made by the U.S. Department of Agriculture in cooperation with the Texas State Soil and Water Conservation Board, the Texas Water Development Board, the Texas Water Rights Commission, and the Interagency Council on Natural Resources and the Environment.

The State expressed need for the study to assist decision makers in coordinating Federal, State, and local agency programs; establishing project priorities; and appraising alternatives for alleviating basic resource problems, and meeting present and projected food and fiber needs. Special interest was expressed in inventorying the quantity and quality of resources available, assessing their productive potential and identifying problems associated with resource development and use.

AUTHORITY

The U. S. Department of Agriculture conducted this study under the authority of Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 83-566, as amended) which authorizes the Secretary of Agriculture to cooperate with State, local, and other Federal agencies in surveys and investigations of the watershed of rivers and other waterways to develop coordinated programs.

PARTICIPANTS

Principal USDA participants include the Soil Conservation Service (SCS), Economic Research Service (ERS), Forest Service (FS), and Agricultural Research Service (ARS). Participation of these agencies was carried out in accordance with assigned responsibilities and coordinated through the Washington Advisory Committee and the Field Advisory Committee. The Field Advisory Committee (FAC), composed of a chairman from the Soil Conservation Service and a member each from the Economic Research

Service and Forest Service, provided guidance to the river basin planning staff. The sponsoring State agencies: Texas State Soil and Water Conservation Board, Texas Water Development Board, Texas Water Rights Commission, and Interagency Council on Natural Resources and the Environment coordinated and provided the major State inputs.

Participation by the sponsors and other State and Federal agencies contributed to the study. Sponsor representatives attended some of the Field Advisory Committee meetings, served on work groups, and expressed their views. They also assisted in the study by securing data from other State and local agencies. In addition, the sponsors assisted in holding public meetings and in preparing the plan of work which set forth the objectives of the study.

Inputs from other agencies, groups, and individuals were in the form of work group participation, providing data, reviewing data, and consultation.

OBJECTIVE

The overall objective is to facilitate and coordinate the orderly conservation, utilization, and management of water, land, and related resources, thereby improving environmental and economical conditions. This broad objective forms a framework for the State's long-range goals to (1) promote efficient planning, development, and use of natural resources; (2) provide planning standards to minimize land use conflicts; and (3) encourage the use of resources in accordance with their inherent capability.

NATURE OF STUDY

The study was limited to investigations necessary to establish the general type, size, location, and priority of measures needed to accomplish flood control and prevention in upstream watersheds, improve impaired drainage of selected agricultural lands, reduce sedimentation and erosion, provide for adequate recreational facilities, protect and enhance fish and wildlife resources, and maintain or improve the environmental quality of the basin. Secondary data and other information were used whenever possible and available . The study results emphasize solutions to problems that can be implemented by U.S. Department of Agriculture programs. However, the report contains recommendations concerning additional needs that will have to be met by other programs. Economic development was considered only to the extent necessary to determine the proper role for water and related lands.

Potential solutions to water and related land problems include structural and non-structural measures. Project and non-project type action was considered. Individual watershed projects found to be needed and economically feasible under present criteria were identified. Their sizes and purposes are compatible with projects planned and installed through Public Law 566.

This report will provide insight on resource availability, current uses, problems, and estimated quantity required to meet short- and long-range needs. It can be used by Federal, State, and local agencies in planning the uses of natural resources. The report should provide a useful reference for decision makers concerned with establishing land use policy plans, developing programs to minimize conflicts among competing resource users, and setting priorities for allocating funds for resource development programs.

The interpretations of comprehensive planning were in such a state of change in the early years of this study that several major revisions of the plan of study were necessary by July of 1975. This last revision established the goal of formulating alternative plans for combining specific components under at least two objectives, National Economic Development (NED) and Environmental Quality (EQ), as described in the Water Resources Council's Principles and Standards and defined in the USDA's guidelines of 1974.

However, the difficulty of converting the study to the new guidelines was seriously underestimated; much of our data and analyses had been previously collected and assembled in a framework and concept of authorization and, as such, lent themselves poorly to the comprehensive planning process required in Principles and Standards. Almost all the material should have been re-done. The short time available compounded with the very size and complexity of the study area dissuaded the participants from returning to the public for the third time to obtain their objective redefinitions. Yet, that would have been necessary to meet the new concept.

Unfortunately, these facts became evident too late; only as the planning staff prepared for the Plan Formulation phase of the study (Chapter 8) did the difficulty of integrating the data without public involvement become evident. By that time it was obvious to the Field Advisory Committee that the October 1977 completion deadline could not be met if the study were to follow the steps and outline of Principles and Standards.

A decision was made in November of 1976 to finish the study on time. To do this required a drastic departure from the

Principles and Standards format. The FAC approved the planning staff's suggestions and recommended that the study report follow Principles and Standards through Chapter 6 and then summarize the findings in the two final chapters which deviate from Principles and Standards.

BASIN DESCRIPTION

The Texas Coastal Basins are located entirely within the State of Texas and include all of 24 counties and portions of 22 other counties (Plate 2-1).

USDA AGENCY RESPONSIBILITIES

Participation of USDA agencies was carried out under assigned responsibilities and coordinated through the FAC as set forth in the Memorandum of Understanding between the Soil Conservation Service, Forest Service, and the Economic Research Service dated April 15, 1968; and SCS-FS Agreement for Coordination of Range Programs on Nonfederal Forest Lands and Inventory of Forests and Rangeland dated June 23, 1976.

The personnel assigned to the study by the three agencies functioned as a collaborating team. Each agency had leadership responsibilities for those aspects of the study as designated.

Soil Conservation Service

The Soil Conservation Service has overall responsibility for the administration and coordination of the USDA activities in the study, giving full recognition to responsibilities otherwise assigned. The SCS in cooperation with other USDA agencies and the various State agencies (1) utilized data available from the Conservation Needs Inventory; (2) evaluated basic physical data pertinent to the study of water and related land resources; (3) compiled soil association maps and interpretations; (4) located and defined floodwater, erosion, sediment, and related problems, (5) determined the extent of agricultural and nonagricultural water management needs; (6) developed potential plans for structural control or management of water; (8) studied all significant phases of public, semipublic, and private recreation and coordinated all recreation planning with comprehensive statewide outdoor recreation plans; (9) made watershed investigations involving engineering, hydrology, economic, geology, biology, agronomy, etc. of designated hydrologic units and considered alternate solutions; (10) described and weighed the impact of proposed measures upon the environment; and (11) exchanged data

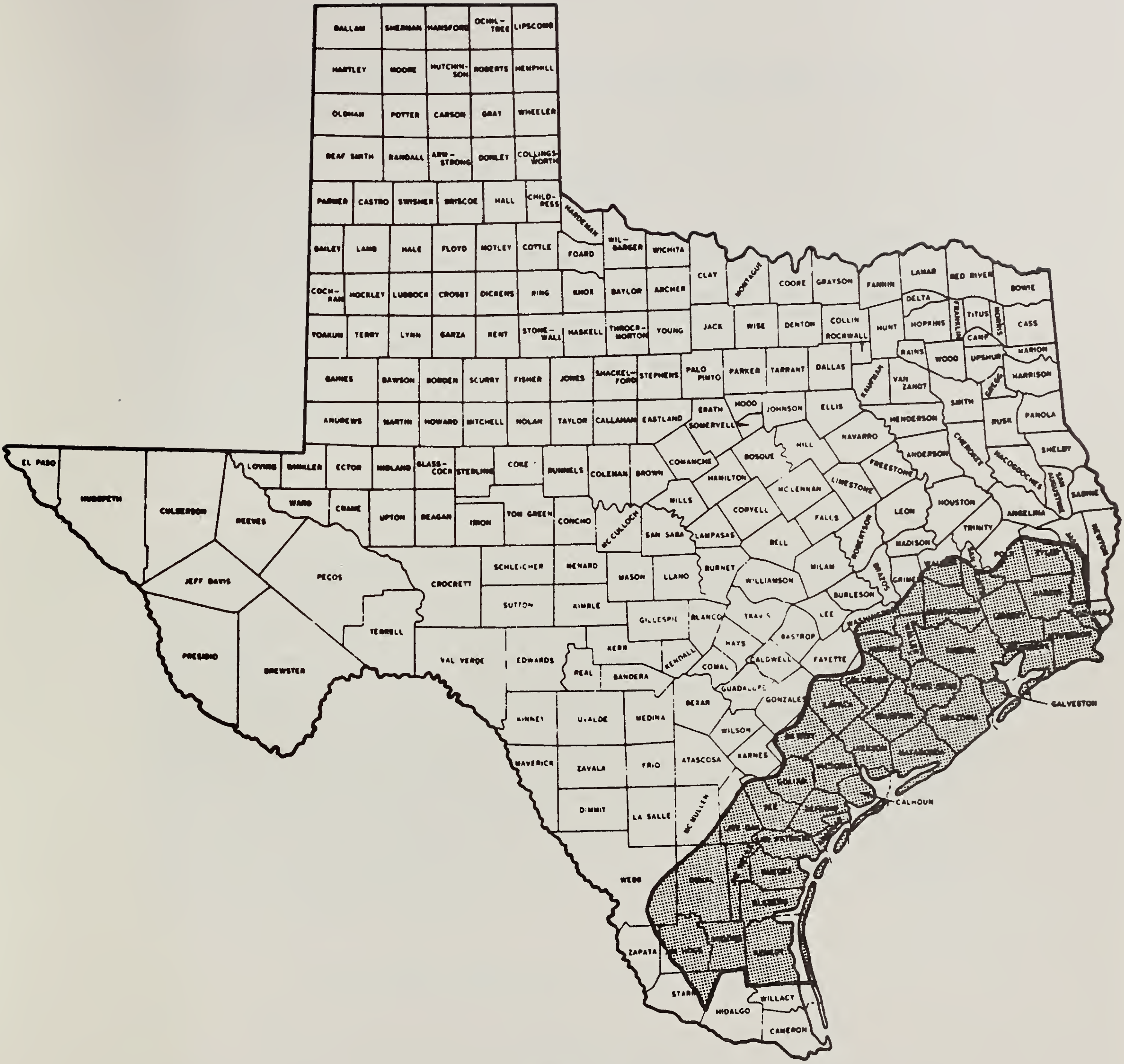


Plate 2-1

STUDY AREA
TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TEMPLE, TEXAS

USDA-SCS-FT. WORTH, TEXAS 1972

8-72 4-L-31961

and coordinated potential projects at the field level with other agencies.

Forest Service

The Forest Service evaluated data pertinent to the study of the forest resource problems and needs; they further described findings and made recommendations to help meet forest land needs and solve forest land problems relative to water resource planning. These data were obtained from USDA Forest Service surveys, watershed surveys, Conservation Needs Inventory, contacts with wood-using industries, the Texas Forest Service, the Texas Forestry Association, forestry schools, research stations, et al.

Economic Research Service

The Economic Research Service, in cooperation with other USDA agencies, compiled economic data and made economic analyses relating to agriculture and its use of land and water resources. The Economic Research Service (1) analyzed the economy of the study area with projection of major economic forces relating to use and development of land and water resources; (2) analyzed the agricultural production potential in relation to resource development opportunities; (3) analyzed the projected need for goods and services from the land and water resources of the study area and the availability of resources, technological advances, and alternatives for production of these products; and (4) appraised the effect of the program and alternative proposals on economic activity in the agricultural and related sectors of the economy and in the overall economy of the study area.

SPONSORING AGENCIES' RESPONSIBILITIES

Texas State Soil and Water Conservation Board

The Texas State Soil and Water Conservation Board's activities are primarily directed along three lines: (1) to perform state-level administrative functions incident to the organization and operation of Soil and Water Conservation Districts; (2) to coordinate the programs of the Soil and Water Conservation Districts; and (3) to administer state responsibilities in the upstream watershed protection and flood prevention program.

In this study, the Texas State Soil and Water Conservation Board coordinated activities that involve Soil and Water Conservation Districts and local entities.

Texas Water Development Board

The Texas Water Development Board has certain technical and planning functions which include the preparation of a comprehensive State water plan and the continuation of technical programs related to water availability, water quality protection, reclamation, and water related services.

The Board maintained close liaison with respect to study progress, programs, assistance needs, and data needs; and has kept informed of resultant plans relative to the State's interest and the Board's responsibilities.

Texas Water Rights Commission

The Texas Water Rights Commission's primary objective is "to conserve this natural resource in the greatest practicable measure for the public welfare" by the administration of water rights, the collection of data, the supervision of certain water districts, and other regulatory activities.

The Commission provided data concerning land and water resources and water rights, coordinated interest of local entities and individuals, participated in work groups, and evaulated data.

Interagency Council on Natural Resources and the Environment

The Interagency Council on Natural Resources and the Environment is a part of the Governor's Division of Planning Coordination. The Council was created as the focal point for all Federal, State, and local agencies to conduct State resource and environmental activities on a joint, cooperative basis.

The Council maintained a close liaison with respect to the progress of studies and activities carried out in the basin which are correlative or parallel to this study.

ACKNOWLEDGEMENTS

To all who collaborated in these undertakings, the Field Advisory Committee (FAC) expresses its gratitude. However, the very number and range of participants make it impractical for the USDA Field Advisory Committee to acknowledge all who have aided and participated in this study. Early in its work the FAC sought to obtain data and reports already prepared pertinent to the Texas Coastal Basins.

The data and reports were obtained from various sources: cities, towns, counties, river authorities, water districts, irrigation districts, drainage districts, council of governments, universities, interested groups and individuals, State agencies, and Federal agencies. Throughout the report, specific acknowledgement is made to a number of sources.

DELINEATION OF BASIN SUBAREAS

For the purpose of identifying flood problems, sediment problems, existing watershed projects, and certain other elements, the basin was divided into three subareas: Lower, Middle, and Upper. Plate 2-2 illustrates the major rivers, coastal basins, and subareas represented in this study.

Lower Subarea

The Lower Subarea consists of the Nueces-Rio Grande Coastal, Nueces River, San Antonio-Nueces Coastal, and San Antonio River drainage.

Middle Subarea

The Middle Subarea consists of the Guadalupe River, Lavaca-Guadalupe Coastal, Lavaca River, Colorado-Lavaca Coastal, Colorado River, Brazos-Colorado Coastal, and Brazos River drainage.

Upper Subarea

The Upper Subarea consists of the San Jacinto-Brazos Coastal, San Jacinto River, Trinity-San Jacinto Coastal, Trinity River, Neches-Trinity Coastal, and Neches River drainage.

Watersheds

A further subdivision of the subareas into watersheds was made. There are 109 individual watersheds which are numbered consecutively in the basin. Plate 8-1, Watersheds, shows them by number and river basin. The watersheds are grouped according to subareas as follows:

Lower Subarea

Nueces-Rio Grande Coastal:

1 Laguna Madre Laterals
2 Palo Blanco
3 Los Olmos Creek
4 Jaboncillos Creek
5 San Diego Rosita
6 Chiltipin-San Fernando
7 Agua Dulce Laterals
8 Lower Agua Dulce Laterals
9 Agua Dulce Creek
10 Oso Creek

Nueces River:

11 Lagarto Creek
12 Ramirena Creek
13 Lower Nueces Laterals
14 West Laterals of Nueces River
15 Sulphur Creek
16 East Laterals of Nueces River
17 San Patricio

San Antonio-Nueces Coastal:

18 Medio Creek
19 Upper Aransas River
20 Chiltipin Creek
21 Blanco Creek
22 Woodsboro-Bonnie View
23 Southwest Copano Bay Laterals
24 Austwell-Tivoli-Refugio

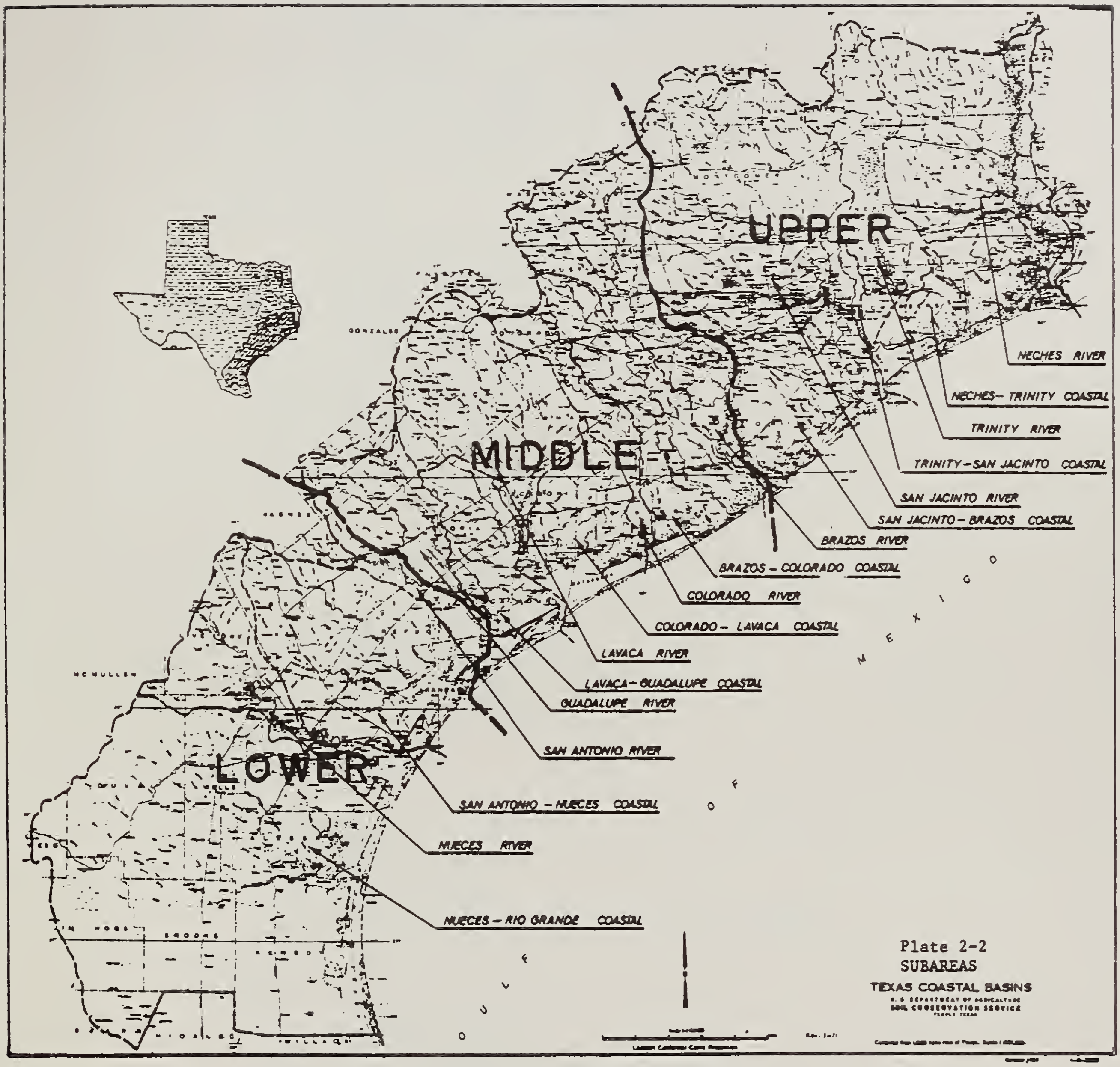
San Antonio River:

25 San Antonio River

Middle Subarea

Guadalupe River:

26 Coleto Creek
27 Lower Coleto Creek
28 Green Lake
29 North Cuero
30 Guadalupe


UPPER
MIDDLE
LOWER
NECHES RIVER
NECHES- TRINITY COASTAL
TRINITY RIVER
TRINITY-SAN JACINTO COASTAL
SAN JACINTO RIVER
SAN JACINTO-BRAZOS COASTAL
BRAZOS RIVER
BRAZOS - COLORADO COASTAL
COLORADO RIVER
COLORADO - LAVACA COASTAL
LAVACA RIVER
LAVACA-GUADALUPE COASTAL
GUADALUPE RIVER
SAN ANTONIO RIVER
SAN ANTONIO - NUECES COASTAL
NUECES RIVER
NUECES - RIO GRANDE COASTAL
G U L F O F M E X I C O
Plate 2-2
SUBAREAS
TEXAS COASTAL BASINS

Lavaca-Guadalupe Coastal:

31 Chocolate-Little Chocolate-Lynns
32 Seadrift-West Coloma
33 Indianola
34 Garcitas Creek
35 Placedo Creek
36 Arenosa Creek

Lavaca River:

37 Chicolete Creek
38 Upper Lavaca
39 Lower Lavaca
40 Upper Navidad
41 Lower Navidad River
42 Sandy Creek
43 Brushy Creek
44 Mustang Creek
45 Pin Oak Creek

Colorado-Lavaca Coastal:

46 Coxs and Kellers
47 Carancahua Creek
48 Turtle Creek
49 Tres Palacios

Colorado River:

50 West Tributaries of the Colorado
51 Jones Creek
52 Blue Creek
53 East Tributaries of the Colorado

Brazos-Colorado Coastal:

54 Peyton Creek
55 East Matagorda Bay Laterals
56 West Tributaries of San Bernard
57 Cedar Lake Creek
58 Caney Creek
59 Live Oak Bayou
60 East Tributaries of San Bernard
61 Turkey Creek
62 Mound Creek

Brazos River:

63 Mill Creek
64 Jones Creek
65 New Years Creek
66 Caney Creek
67 Piney Creek
68 Allens Creek
69 Big Creek
70 Southwest Brazos Laterals
71 Cow Creek
72 Varner Creek
73 Lower Oyster
74 Upper Brazos River
75 Bessies and Irons Creek
76 Oyster Creek

Upper Subarea

San Jacinto-Brazos Coastal:

77 Bastrop Bayou
78 Austin-Flores Bayous
79 Chocolate Bayou
80 Mustang and Hall's Bayou
81 Clear Creek
82 Dickinson Bayou
83 Highland Bayou
84 Moses Bayou

San Jacinto River:

85 Lower West Fork San Jacinto
86 Spring Creek
87 Cypress Creek
88 Buffalo Bayou
89 West Fork San Jacinto
90 East Fork San Jacinto
91 Caney Creek (Montgomery)
92 Lower San Jacinto

Trinity-San Jacinto Coastal:

93 Cedar Bayou

Trinity River:

94 Old River
95 Lower Trinity
96 Upper Trinity
97 Middle Trinity
98 Turtle Bayou

Neches-Trinity Coastal:

99 Spindletop Bayou and Others
100 Spindletop Marsh
101 East Bay Bayou
102 Taylors Bayou
103 Salt Bayou

Neches River:

104 Eastern Pine Island Bayou
105 Western Pine Island Bayou
106 Upper Village Creek
107 Lower Village Creek
108 Upper Neches River
109 Lower Neches River

CHAPTER 3

PROBLEMS AND OBJECTIVES

TEXAS COASTAL BASINS

CHAPTER 3

PROBLEMS AND OBJECTIVES

INTRODUCTION

The water and related land resource problems in the Texas Coastal Basins involve a number of inter-related physical, social, economic, and environmental concerns. As a result of 34 public meetings, numerous interviews, and other public contacts, the major resource problems were identified.

The Texas Coastal Basins study was conducted, as near as possible, in accordance with the "Principles and Standards for Planning Water and Related Land Resources" developed by the Water Resources Council which became effective October 25, 1973. The implementation of the Principles and Standards for this study were guided by the "USDA Procedures for Planning Water and Related Land Resources", dated March 1974.

Modification to the Plan of Work and the Work Outline were made to incorporate the Principles and Standards.

PROBLEMS

Each of the identified water and related land resource problems or study concerns must clearly be related to either the NED or the EQ major objectives. Solutions to problems related to NED reflect increases in the Nation's productive output, an output which is partly reflected in a national product and income accounting framework designed to measure the continuing flow of goods and services into direct consumption or investment.

Solutions to problems related to EQ reflect man's abiding concern with the quality of the natural physical-biological system in which all life is sustained.

Floodwater Damages

Flood problems are of two distinct types. One is associated with floods that occur in the upstream watersheds along streams having well-defined flood plains. Floods in the upstream watersheds generally rise and fall quickly and have high velocities and high peak discharges. Damages per acre inundated from floods in the upstream reaches are usually lower than those occurring downstream due to less intensive use. Where damage occurs the ever present flood hazard may be a deterrent to more intensive use of these flood plains.

The other type of flood problem is associated with accumulation of runoff on the almost flat terrain of the coastal areas. Control and disposal of this surface runoff is one of the most serious water problems faced by cities and farming communities. Floodwaters interrupt transportation and damage crops and residential, commercial, industrial and other buildings, and interfere with the proper treatment of sewage.

Flood-producing storms can occur at any time of the year; however, they occur most frequently during the spring and fall months. Floods occur in some parts of the study area each year. These are usually caused by local storms of high intensity. Widespread flooding is associated with storms covering large areas and with heavy rainstorms that accompany hurricanes. Some of the more recent major floods associated with hurricanes are Carla, 1961; Cindy, 1963; Beulah, 1967; Celia, 1970, and Fern, 1971.

Flooding and its resultant damage is a major problem on agricultural lands. Most of the floodwater damages are caused by ponding of excess water from rainfall. Water tends to accumulate rather than run off because of the flat topography, lack of natural channels, and inadequate drainage systems.

Highways, roads, railroads, and irrigation canals have been built across the study area in all directions. These manmade obstructions block natural flows and cause inundation of large areas of cropland and improved pasture. In many cases these restrictions cause water to stand for long periods in highly developed urban areas, resulting in extensive damage to property and loss of business. Often schools are forced to close for several days until the water recedes. Flooding of sanitation facilities compounds the health hazard.

Floodwater damages occur on 7,296,500 acres with estimated average annual losses of $66,660,000 to cropland, pastureland, urban and built-up areas. Table 3-1 shows the estimated area subject to flood damage.

TABLE 3-1

Estimated Area Subject to Flood Damages

Texas Coastal Basins

(1975)

Land Use	Acres
Cropland	2,718,200
(Dry)	(1,939,000)
(Irrigated)	(779,200)
Pastureland	1,417,700
Rangeland	1,567,100
Forest Land	1,148,300
Other Land	126,500
Urban and Built-up	273,900
Federal Land	44,800
TOTAL	7,296,500

Source: River Basin Staff, SCS

Impaired Drainage

Many drainage systems and isolated ditches have been constructed by drainage districts, counties, individual landowners, irrigation districts, and cities in an effort to improve the drainage conditions of their respective localities. These facilities have improved drainage conditions to some extent. Much work has been done on the upper reaches of natural streams that serve as outlets for many of the systems. Damages have been caused farther downstream by the faster concentrations of runoff water from the improved facilities. The problem is that the systems do not have adequate outlets.

From Victoria and Calhoun counties southward, there are numerous swales and potholes. These are local terms for two types of natural depressions. The term "swales" usually means a wide, shallow meandering depression that does not have a definite or continuous channel, but does have an outlet. Such depressions are often the headwaters of the local streams. Isolated depressions with no outlets are referred to as "potholes; however, the term "swales" is sometimes applied to these also. The runoff water from surrounding areas collects in the bottoms of these depressions and remains there until removed by evaporation or absorption. Crops are seriously damaged or destroyed. These depressions do not have outlets and do not follow definite patterns. Since this is in the low rainfall section of the study area and moisture conservation is important, level terraces reduce the amounts of water reaching the bottoms of these depressions and conserve moisture.

On rangelands, the lack of continuous or definite channels in the swales causes lakes of various sizes and depths to remain after most of the surface water has drained off. These low, wet places become breeding and concentration places for cattle diseases. The standing water damages or destroys the pasture grasses; thereby, reducing the grazing area. Potholes create the same problem.

Large acreages in the bottomland of the Neches, Trinity, Brazos, San Bernard, Guadalupe, and Nueces rivers cannot be feasibly drained until the floods that occur on these streams are brought under control. Each flood would partially or completely damage any drainage installation.

The marsh areas in Orange, Jefferson, and Chambers counties present a problem which is closely connected with draining the adjoining farm and ranch lands. Large sections of the marshes are used for wildlife and these will have to be protected where drainage outlets are constructed to the Gulf.

Drainage ditches have been installed for many years, but their adequacy has failed to keep pace with the needs, especially in the areas of urban runoff. Most systems at present are only partially effective due to lack of capacity, improper maintenance, deterioration of structures, and most important the absence of adequate outlets.

Almost all the rice grown in Texas is within the study area. Although rice is grown in flooded fields, adequate surface drainage is needed for the timely removal of water during seedbed preparation, planting, and harvesting.

Soils with slow internal drainage and inadequate surface drainage result in delayed plantings, additional farming operations, and untimely harvests which reduce yields, lower quality, and increase production costs.

Impaired surface drainage is limiting agricultural production on about 5,581,600 acres in the study area. Table 3-2 shows the agricultural uses of land inadequately drained.

TABLE 3-2

Land Inadequately Drained

Texas Coastal Basins

(1975)

Land Use	Acres
Cropland	2,584,300
(Dry)	(1,830,200)
(Irrigated)	(754,100)
Pastureland and Rangeland	1,931,800
Forest Land	1,065,500
TOTAL	5,581,600

Source: River Basin Staff, SCS

The problems of inadequate drainage on flatlands are considered inseparable from problems of flooding. Thus, the acreage with drainage problems is considered to have a combined problem of inadequate drainage and flooding. The drainage area map, Plate 3-1, shows the areas needing drainage as well as the areas having adequate outlets. The uncolored portions represent marshes, flooded areas, and other areas having adequate natural drainage.

Water Shortage

Areas which will face critical water shortages in the future include the Houston metropolitan area and the Corpus Christi and Kingsville areas. The Corpus Christi and Kingsville areas will probably develop a shortage of freshwater around the year 2000 even considering the yield of the proposed Choke Canyon Reservoir. Other major problems relating to water supply in the study area include water quality management, land subsidence, and saline ground water intrusion in the Gulf Coast aquifer. As inland freshwater supplies are progressively developed and used, freshwater inflows to the bays and estuaries will be correspondingly diminished.

Land subsidence, resulting largely from localized intensive ground water pumpage and also withdrawals of petroleum, natural gas, and brine from hydrocarbon reservoirs, is a very severe problem in Orange County along the Houston ship channel and in the vicinity of Baytown. Along the Houston ship channel the ground has subsided as much as five feet since 1943. Heavy ground water pumpage has also caused saline-water intrusion in the Texas City and Baytown areas.

The rate of natural recharge is estimated to be sufficient to sustain the present level of pumpage from the aquifer except in the Houston metropolitan area. The principal problem restricting maximum development of the aquifer is the limited capability of the aquifer to transmit water from areas of recharge to areas of pumpage.

Although a limited supply of surface water is available for use in the intervening areas along the coast, the major source of surface water is from the seven major streams that originate above the study area and flow across it.

The large industrial and agricultural sectors of the dynamic economy of the Texas Coastal Basins require and use vast quantities of water. Large population centers which have developed in the heavily industrialized areas have also created great local demands for freshwater. Collectively, municipalities, domestic, industrial, agricultural, and maintenance of adequate environmental conditions of the estuaries make the coastal area the greatest demanding area of Texas.

The current freshwater demands can be met with the existing supply. However, as each sector increases its water demand, then priority will determine water use. Statutory priority in appropriation for water shall be given in the order named: (1) domestic and municipal, (2) industrial, (3) irrigation, (4) other beneficial uses.

Any significant new demands will require development of surface water resources. Table 3-3 shows the annual water use.

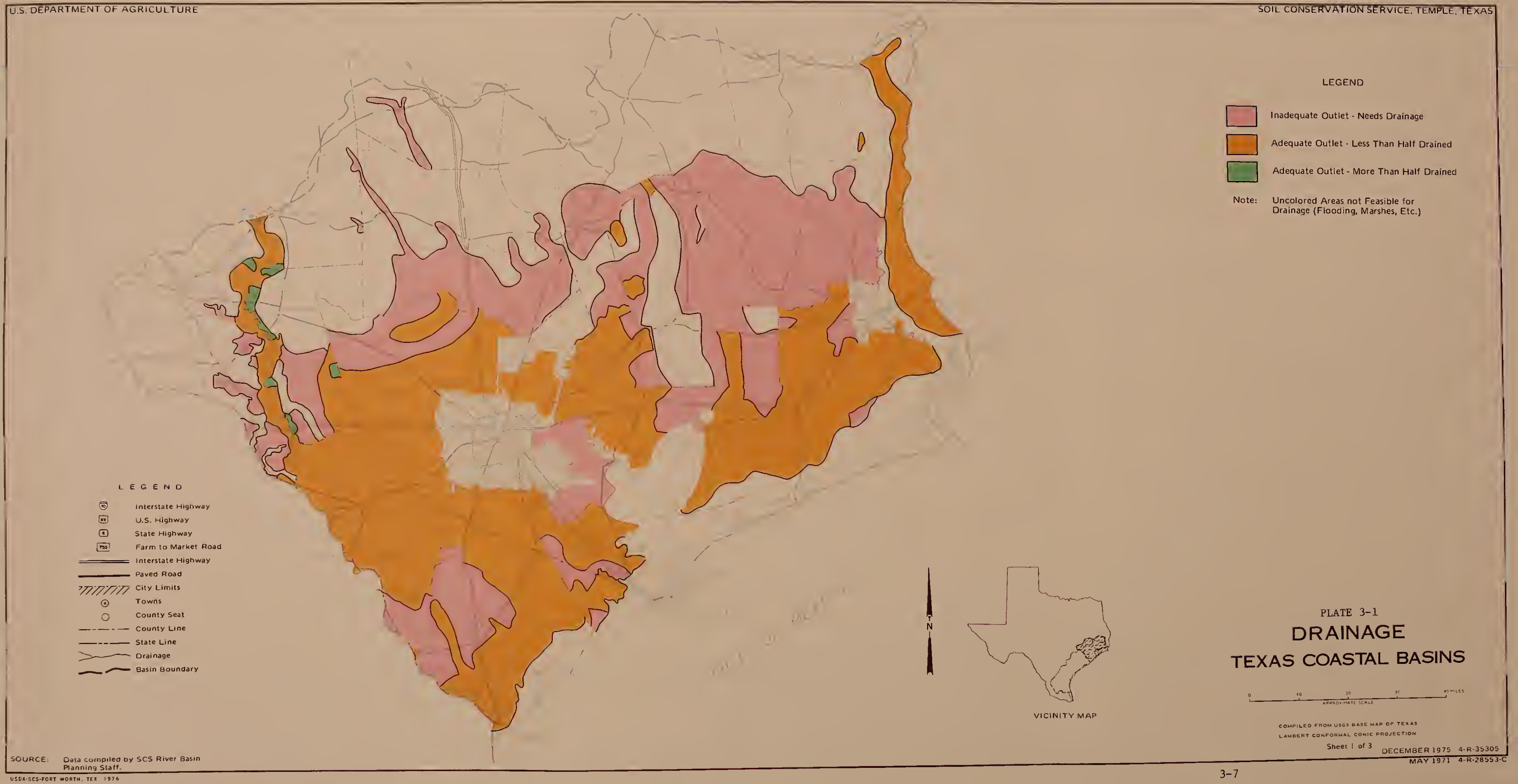
TABLE 3-3

Annual Water Use

Texas Coastal Basins
(1974)

Use	Surface Water	Ground Water	TOTAL
	AC-FT/YR		
Irrigation	979,522	675,516	1,655,038
M&I	1,112,200	773,900	1,886,100
TOTAL	2,091,722	1,449,416	3,541,138

Source: Texas Water Development Board


U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, TEMPLE, TEXAS
LEGEND
Inadequate Outlet - Needs Drainage
Adequate Outlet - Less Than Half Drained
Adequate Outlet - More Than Half Drained
Note: Uncolored Areas not Feasible for Drainage (Flooding, Marshes, Etc.)
LEGEND
Interstate Highway
U.S. Highway
State Highway
Farm to Market Road
Interstate Highway
Paved Road
City Limits
Towns
County Seat
County Line
State Line
Drainage
Basin Boundary
N
VICINITY MAP
PLATE 3-1
DRAINAGE
TEXAS COASTAL BASINS
0
10
20
30
40 MILES
APPROXIMATE SCALE
COMPILED FROM USGS BASE MAP OF TEXAS
LAMBERT CONFORMAL CONIC PROJECTION
Sheet 1 of 3
DECEMBER 1975 4-R-35305
MAY 1971 4-R-28553-C
SOURCE: Data compiled by SCS River Basin Planning Staff.
USDA-SCS-FORT WORTH, TEX 1976

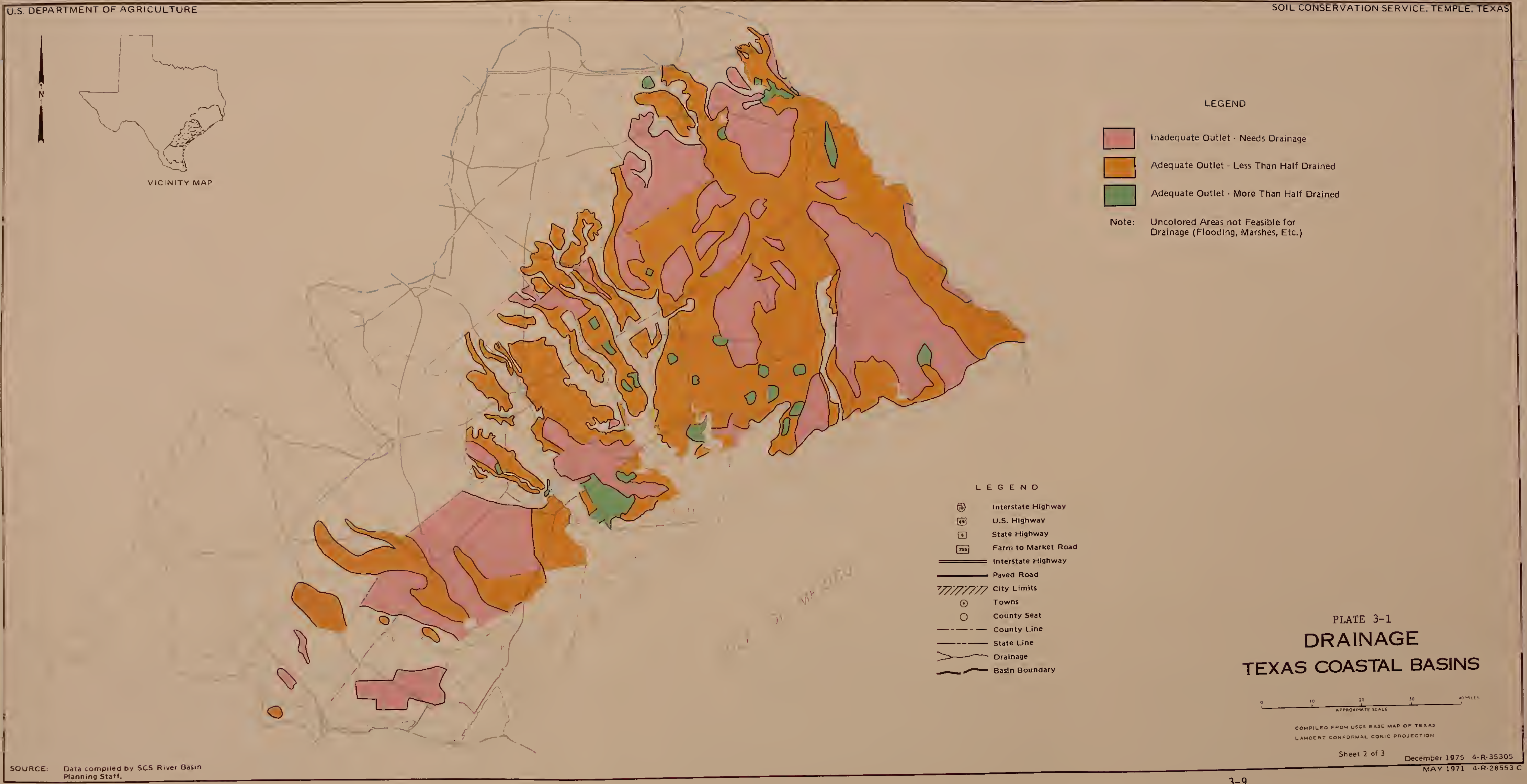
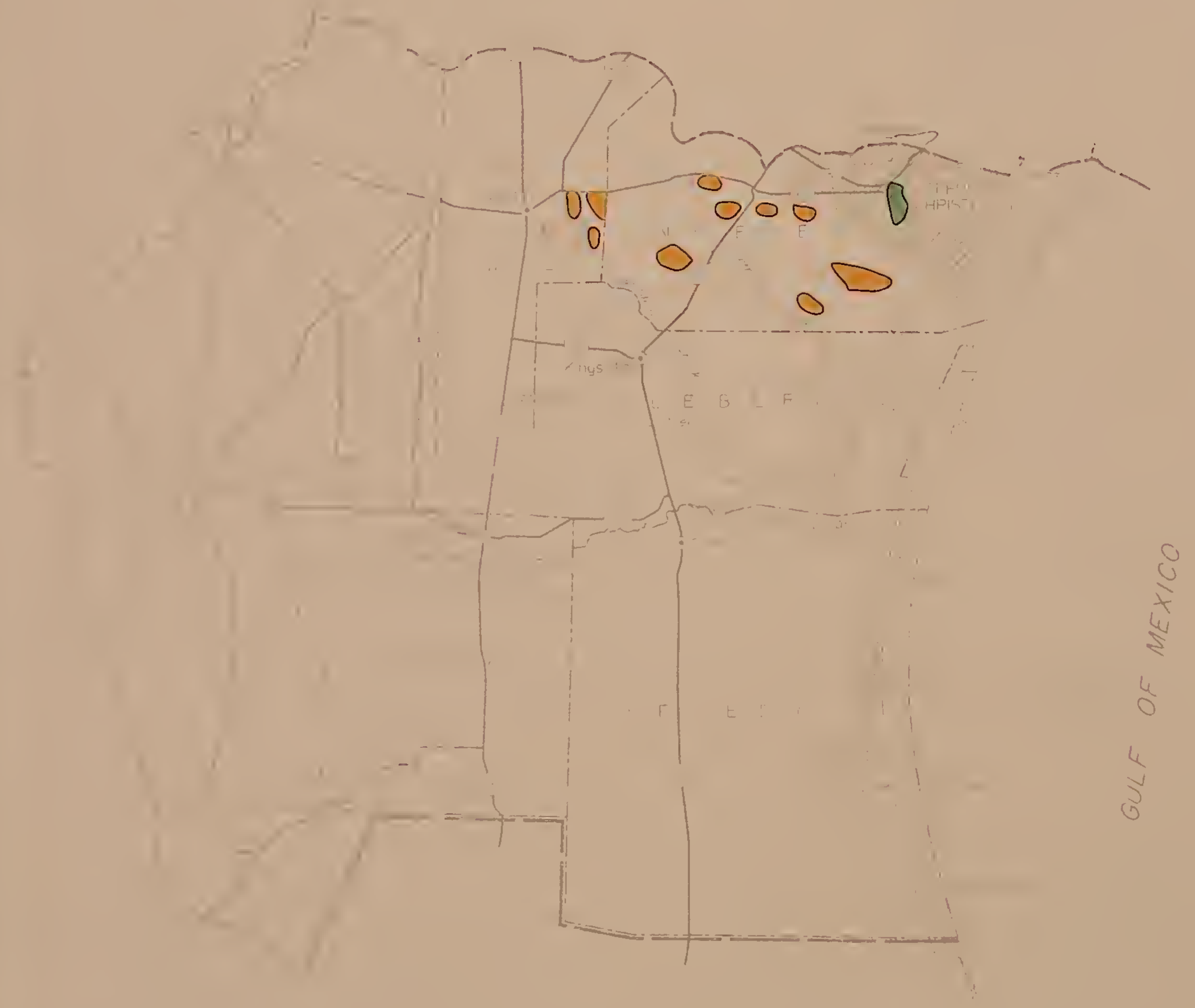


PLATE 3-1
DRAINAGE
TEXAS COASTAL BASINS

USDA-SCS FORT WORTH TEX 1976



LEGEND

- Inadequate Outlet - Needs Drainage
- Adequate Outlet - Less Than Half Drained
- Adequate Outlet - More Than Half Drained

Note: Uncolored Areas not Feasible for Drainage (Flooding, Marshes, Etc.)

LEGEND

- Interstate Highway
- U.S. Highway
- State Highway
- Farm to Market Road
- Interstate Highway
- Paved Road
- City Limits
- Towns
- County Seat
- County Line
- State Line
- Drainage
- Basin Boundary

VICINITY MAP

PLATE 3-1

DRAINAGE
TEXAS COASTAL BASINS

APPROXIMATE SCALE

COMPILED FROM USGS BASE MAP OF TEXAS
LAMBERT CONFORMAL CONIC PROJECTION

Sheet 3 of 3

DECEMBER 1975 4-R-35305
MAY 1971 4-R-28553 C

SOURCE: Data compiled by SCS River Basin Planning Staff.

USDA-SCS-FORT WORTH TEX 1976

Recreation

Presently, developed recreational facilities are not adequate to meet the demand. Some of the higher priority needs at this time are picnic tables, boat ramps, swimming pools, and trails of all kinds. In order to alleviate this current problem, an intensive effort will be needed by cities, counties, State, Federal, and private enterprise, Table 3-4.

Uneven distribution of facilities, resources, and needs are other problems to be reckoned with. A much greater need exists in the Upper and Lower Subareas than in the Middle Subarea for campsites, walking trails, and designated swimming areas. The need for golf courses is far greater in the Upper Subarea than in either of the other two subareas.

Water-oriented recreation is confined largely to coastal waters of the Gulf of Mexico due to the absence of reservoirs and State parks with water bodies. The continuing capability of the coastal area to provide adequate recreation is being impaired because of increasing expansion of industrial and private development along the coast. Public access to beaches from mean low tide to the vegetation line is set forth in the "open beaches" law, but the area is undefined along vast stretches of the coast. There is also a recognized shortage of access by roads to bays, estuaries, and other existing public waters.

Other problems affecting recreation in the coastal area include shoreline erosion, tidal damage, and pollution. High tides, due to hurricanes, inflict heavy damage to barrier island and beaches.

Pollution is a very serious threat to outdoor recreation largely due to heavy use of the coastal waters for transportation, industrial purposes, and as a disposal area for by-products of an affluent society. Indiscriminate dumping of foreign matter into bays, estuaries, and coastal streams kills fish, damages habitat, and deters swimming and boating activities.

There are problems in securing land for recreational opportunities where it is mostly needed - near densely populated metropolitan areas. Recreation has not been able to compete successfully with other uses for land. This situation is complicated by the lack of land use guidelines which could encourage the purchase of land for open space and recreational areas.

TABLE 3-4

Supply and Demand for Selected Recreation Activities

Texas Coastal Basins

Activities	Supply	Demand 1970
	----- 1000 Man-Days	---------
Camping	1,658	5,434
Child's Play	23,431	10,316
Golf	1,807	2,934
Baseball	7,226	2,306
Picnicking	7,472	9,437
Trails -Horse		
-Walking		
-Bicycle		
TOTAL	2,041	36,133
Swimming - Pool		
- Designated Fresh Water		
TOTAL	8,588	15,808
Watersports	20,193	1,682

Source: Information compiled by River Basin Staff from data taken from Texas Outdoor Recreation Plan.

Erosion

The erosion rates within the basin vary considerably, as shown in Table 3-5, because they are influenced by land use, soil type, rainfall, and physical characteristics of landscape all of which have considerable ranges within themselves. The lowest rates, one ton or less per acre, are in the flat-lying coastal areas of primarily clayey soils, and the highest are in areas of gully erosion in San Patricio County.

Erosion by water within the study area displaces about 28,958,500 tons of soil each year. Table 3-6 summarizes the estimated gross tons of sheet erosion occurring by land use.

Table 3-7 summarizes the estimated average annual physical damage incurred by erosion and sediment.

TABLE 3-5

Range of Annual Soil Loss Erosion

Texas Coastal Basins

Kind of Land	Range of Annual Soil Loss (Tons/Acre)
Forest	0.15 to 21.49
Irrigated Rice and Marsh	0.1 to 1.0
Level Pasture	1.0 to 5.0
Level Cultivated	4.0 to 8.0
Rolling Pasture	4.0 to 10.0
Rolling Cultivated	10.0 to 15.0
Gully	100.0 to 200.0

Source: River Basin Staff, SCS

TABLE 3-6

Gross Tons from Sheet Erosion

Texas Coastal Basins

(1970)

Land Use	Gross Tons
Irrigated Cropland	227,900
Dry Cropland	12,967,400
Pastureland	2,925,200
Rangeland	8,547,400
Urban	88,400
Forest Land	4,177,000
Marshland	11,800
Other Land	13,400
TOTAL	28,958,500

Source: River Basin Staff, SCS

TABLE 3-7

Estimated Average Annual Erosion and Sediment Damages

Texas Coastal Basins

(1970)

Source	Unit	Average Annual Rate
Scour	Acres Damaged	11,100
Sediment	Acres Damaged	39,400
TOTAL	Acres Damaged	49,500
Gully	Acres Lost	68
Streambank	Acres Lost	133
Shoreline	Acres Lost	109
TOTAL	Acres Lost	310

Source: River Basin Staff, SCS

Table 3-8 shows the estimated average sediment yield to the bays and estuaries.

TABLE 3-8

Estimated Average Annual Sediment Yield to the Bays and Estuaries

Texas Coastal Basins

(1970)

Source	Average Annual Rate (Tons Delivered)
Sheet	6,670,400
Gully	526,300
Streambank	1,186,800
Roadside	507,600
Shoreline	1,021,000
TOTAL	9,912,100

Source: River Basin Staff, SCS

Critical erosion is occurring on portions of the Gulf Coast Prairies Land Resource Area occupied by Victoria clay soils in San Patricio County. These soils have a high shrink-swell ratio and are somewhat dispersed, especially when soluble salts from oil field pollution are present. Extensive cracks develop when these soils dry, causing them to become highly susceptible to gully-like erosion. Nearly vertical banks are formed, and blocks of dry soils break off and fall into the ditch bottom. Several drainage ditches have been cut against grade into Nueces Bay from the north in these soils. Considerable erosion of the bank and beds has caused these ditches to deepen and widen in an uncontrolled manner. This has formed unsightly gullies and deposited large quantities of sediment in Nueces Bay.

Stabilization structures have been installed in several of these eroding ditches. Due to the difficult soil conditions, proper design and installation of these measures are mandatory to decrease the risk of failure. Several eroding ditches are present which drain northward and empty into Chiltipin Creek. Some gully erosion is present in the upland portions of the Guadalupe and the San Antonio River basins, and has contributed to the large sand bedload of Coleto, Perdido, and Turkey creeks in the Guadalupe River Basin and Manhuilla Creek in the San Antonio River Basin.

No critical roadside erosion has been observed in the study area.

Active streambank erosion was observed along many of the streams and tributaries in the upland watersheds, particularly in the Guadalupe River Basin. Active bank erosion is occurring along several of the major rivers; most noticeably the Brazos River. This is a natural process and is the means by which the rivers meander back and forth across their valleys to build wide, flat flood plains.

The principal wind erosion problem is located in eastern Kenedy County on what is known as the Laguna Madre Salt Flats between Padre Island and the mainland. Construction of the Intracoastal Waterway effectively drained these flats so that they are dry a large part of the time and subject to erosion by the prevailing southeast winds. Also, extensive grazing on Padre Island in the past and wind erosion of the spoil banks along the Intracoastal Waterway contribute to the problem. The prevailing winds pick up salt laden dust and sand, and blow it into the waterway and far inland where it is deposited on vegetation. The resulting defoliation of the vegetation promotes the creation and movement of sand dunes across Kenedy County from the southeast. The deposition of sand in the waterways is a maintenance problem as is the deposition of salt on transformers and power lines. No other parts of the study area appear to have a significant wind erosion problem.

Shoreline erosion is significant along many miles of bay and estuary shore behind the barrier islands and on the open Gulf shore where no barrier island is present. Erosion on the Gulf beaches of the barrier islands is generally not important or relevant. Erosion of the shoreline is not only causing a loss of land and improvements but also contributing to the pollution of the bays and estuaries. Recreational beaches are being damaged in some areas and the erosion is contributing to the maintenance requirements of channels and waterways.

A study of shoreline erosion has been conducted by the U. S. Corps of Engineers under the authority of Section 106, Public Law 90-483. The SCS furnished available data on areas of shoreline erosion.

The Corps of Engineers study showed that about 350 miles of shoreline is eroding and is resulting in the loss of about 125 acres of land annually. This study also shows that about 36 miles of Gulf shoreline and about 57 miles of bay and estuary shoreline is classed as having critical erosion. Erosion was termed critical when evaluation indicated that action to halt such erosion may be justified. About 65 miles of Gulf shoreline and 192 miles of bay and estuary shoreline is classified as having noncritical erosion. These studies show that major areas of critical shoreline erosion include the north shore of Nueces and Corpus Christi bays, the west shore of Lavaca and Matagorda bays, the west shore of Galveston Bay, and the open shoreline from Port Bolivar to the Sabine River.

Generally speaking, on-site erosion on forest land is not a problem. The average loss rate is only 0.80 tons per acre per year, which is well within the tolerances allowed for on-site damages or fertility loss. Local exceptions do exist however, and most of these occur in the Piney Woods region. In these locally eroding areas, the major sources of erosion are logging spur roads, site preparation practices, and overgrazing (Table 3-9).

In judging erosion severity, the rate of erosion, on a volume or weight per unit area per unit time basis is most significant. Simply stating a large volume or weight of eroded matter is meaningless if not also expressed in terms of some erosion rate. Grazing provides an excellent example. Although forest grazing is a widespread practice, actual overgrazing is a problem on less than 10 percent of the grazed forest. Since grazing is so common, it contributes nearly 61 percent of the total eroded matter from the basin's forest lands. But the rate of this erosion is a mere 0.8 tons per acre per year. Reducing a rate this low would be a difficult and expensive process.

Erosion from logging spur roads provides a different look at the relationship between total eroded matter and erosion rates. Spur roads are minor in their overall contribution to the erosion problem, only 5.0 percent of the total erosion from forest land, but the rate of erosion averages 21.5 tons per acre per year. This indicated that erosion from spur roads is a serious problem in some small local areas but is not a major difficulty on a basin-wide basis. These local erosion problems with high rates are much more subject to preventive and remedial treatment by local land managers.

TABLE 3-9

Forest Land Average On-Site Erosion Rates

Texas Coastal Basins

(1970)

Source	Annual Erosion	Area	Percent of Total Volume Erosion	Average Erosion Rate 1/
	(tons)	(acres)	(percent)	(tons/ac/yr)
Natural	678,000	4,435,000	16	0.15
Logging	281,000	346,000	7	0.81
Skid Trails	31,000	11,000	1	2.87
Spur Roads	217,000	10,000	5	21.49
Fire	40,000	88,000	1	0.46
Grazing	2,494,000	3,246,000	60	0.77
Site Preparation				
Chopping	236,000	106,000	5	2.21
Discing	200,000	61,000	5	3.29
TOTAL	4,177,000	4,435,000	100	0.94

1/ The erosion rates expressed here are accelerated rates. For example: the accelerated rate for logging is 0.96 minus the natural rate 0.15 or 0.81 tons per acre per year.

Source: Forest Service, USDA

Between these two extremes, we have the case of site preparation by chopping or discing. These practices contribute 4 and 5 percent of the total erosion tonnage each year, and do so at rates averaging 2.3 tons per acre per year. But these rates, although higher than the overall basin average, are quite low on the absolute scale, and can be reduced through intelligent management pracitice and careful equipment operation.

Sedimentation

The study of sediment yield and deposition in the study area can be divided into two categories: (1) that which originates outside the study area, and (2) that which originates within the study area.

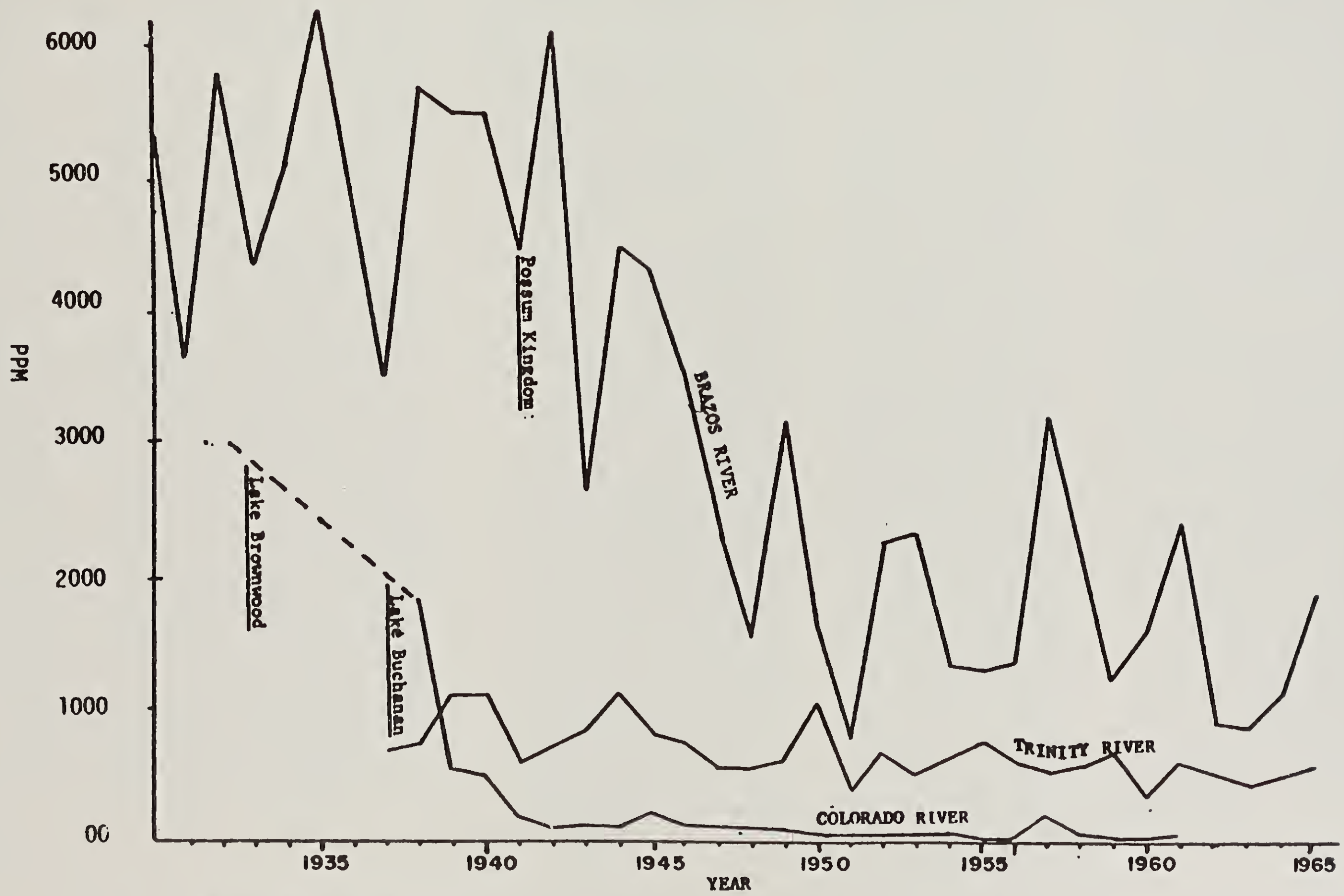
Sediment which originates outside the study area is transported into and through it by the seven rivers on their way to the Gulf. It is estimated that under present conditions these river transport a total of about 15,000 acre-feet or about 23,690,200 tons of sediment to the bays and estuaries annually, of which about 9,463,900 tons originate within the study area and 14,226,200 tons from outside the study area. It is estimated that 60 to 70 percent of this sediment is deposited in the bays and estuaries, the remainder entering the open Gulf through openings in the barrier islands. By far the largest sediment load is carried by the Brazos River which accounts for about 12,534,000 tons. A comparison of old and new bathometric charts indicates that the bays and estuaries are filling at an average rate of about 1.25 feet per century. Studies have shown that the filling rates of the bays and estuaries are actually about double the rate indicated by the bathometric depth changes. Subsidence within the Gulf Coast geosyncline accounts for the difference.

Indications are that recent dams on the rivers along with installation of needed soil conservation measures such as land treatment and flood prevention structures have probably altered this rate, causing a considerable decrease. This is confirmed by an analysis which was made of the sediment loads of the major rivers during a 35-year period ending in 1965. Figure 3-1 shows the sediment loads of three major rivers which pass through the study area. Particularly noteworthy is the large quantity of sediment carried by the Brazos River as compared to the Trinity and Colorado rivers. A sharp decrease in the load carried by the Colorado River occurred after the installation of the dams at Austin. It is interesting to note that the Brazos and Colorado rivers historically have carried very large sediment loads and this apparently correlates with their being the only two major rivers which have completely filled their drowned estuaries. With the reduction of sediment from

FIGURE 3-1

Historic Suspended Sediment Loads

Texas Coastal Basins



Source: River Basin Staff, SCS

inland sources due to dam building and soil erosion prevention measures, it is quite possible that the rate of shoreline erosion around the bays and estuaries will increase, due to the upsetting effect on the deposition-erosion equilibrium.

Several spectacular examples of accelerated sedimentation are present in the study area. One example is the deposition of significant amounts of sediment in Nueces Bay as a result of degrading drainage ditches along its north shore. Several deltas covering many acres have been built at the mouths of these drains within the last 30 years. One such delta, at the mouth of Gum Hollow Creek, occupies an area of 127 acres and actively advances itself after every heavy rain on its contributing watershed.

This erosion and deposition is the result of the construction of an artificial drainage system to drain the area between the cities of Portland and Taft. The outlet of the manmade system was into Gum Hollow Creek, which until that time had a very small drainage area. Early growth of the fan delta was rapid because of the tremendous volume of sediment made available by undercutting of spoil banks.

Another example of localized accelerated sediment yield to the bays is the rapid growth of the Colorado River delta across the east arm of Matagorda Bay. Prior to 1926 sedimentation at the mouth of the Colorado River was greatly impeded by a logjam in the lower part of the river which caused flooding and spreading of sediment over the lowlands. Between 1926 and 1930 the logjam was removed and the channel opened. As a result, the Colorado River built a delta across East Bay, a distance of four miles, in about six years.

In the Lavaca River Basin the soils of the Texas Claypan Land Resource Area are producing sandy sediment which clogs tributaries of the Navidad River such as West, Middle, and East Sandy creeks. In the Guadalupe River Basin large quantities of clean sand are present as bedload in Coleto, Perdido, and Turkey creeks. The San Antonio River Basin contains a large quantity of sand bedload. The sand is clean, fine to medium grained quartz, and is evidently 10 to 15 feet deep in some places. The deposition of sand in these creeks has reduced their capacity to carry floodwaters within their banks.

The forest lands in the basins produce very little sediment. Present sediment yields are averaging only 0.4 tons per acre per year, 90 percent of which comes from the Piney Woods Region (Table 6-14).

The 1975 data indicate that logging spur roads associated with timber harvesting activities are the single largest source of sediment from forest land, yielding some 3.7 tons per acre per year while contributing 38 percent of the total sediment volume. As indicated by the low basinwide sediment yield, sediment from spur roads is a local problem directly related to the erosion from these same distrubances. They are not a problem requiring basinwide attention. Sound local land management is the answer to this problem.

Grazing lands have a rate of only 0.02 tons per acre per year.

Land Use and Management

Paramount in a discussion of land use and management problems is the noted absence of guidelines and incentives to encourage sound land use planning and the adoption and enforcement of meaningful land use policies. One objective in land use planning is to describe the compatible and conflicting uses and combination of uses for a land area using criteria designed to maximize the social benefits and minimize the social costs. In the Texas Coastal Basins improper land use planning, such as buildings constructed in flood plains and on soils poorly suited for construction purposes, has resulted in costly flood damages, drainage and health problems, structural failures, and a host of other mistakes in land development. Soil erosion, loss of plant cover, and impairment of natural beauty have resulted because the natural characteristics of the land and man's use of it are in conflict. Many water related land resource planning problems can be minimized, and some can be avoided by planning for wise use of land resources.

There are about 6.8 million acres of soils in the Texas Coastal Basins with a primary limitation of erosion (Table 3-10). There are 861,300 acres of cropland on which erosion is the main limitation to use.

Wetness is the most pressing problem of natural resource management in the Texas Coastal Basins. About 5.6 million acres have a severe wetness problem. Wetness not only reduces productive capability but interferes with the timing of cultural operations.

About 5 million acres have an unfavorable soil condition in the Texas Coastal Basins.

There are about 0.8 million acres in the Texas Coastal Basins on which lack of moisture is the limiting factor. A lack of irrigation water and consistent rainfall is the problem.

TABLE 3-10

Potential Hazards
Agricultural Lands

Texas Coastal Basins

Soil Limitation	Cropland (Ac)	Rangeland (Ac)	Pastureland (Ac)	Forest Land (Ac)	Other (Ac)	Total Agricultural Land (Ac)
Erosion 1/ Hazard	861,300	3,489,700	873,800	1,381,500	191,200	6,797,500
Wetness 2/ Hazard	1,304,200	1,198,100	864,600	2,074,800	184,200	5,625,900
Unfavorable Soil Condition 3/	1,786,300	1,958,700	640,500	457,200	246,600	5,089,300
Climatic Hazard 4/	232,500	481,500	59,500	3,300	13,500	790,300

1/ Primary limitation is risk of erosion.
2/ Excess water in or on the soil which limits plant growth and inhibits cultural practices.
3/ Soils that limit root development or have low moisture-holding capacity.
4/ Climate (lack of moisture) is the major hazard or limitation in their use.

Source: Conservation Needs Inventory (CNI) 1970

A significant problem on rangeland is the encroachment of brushy vegetation. Over three million acres of the study area has a severe brush problem. Control methods are limited and costly. Brush control is complicated by the assorted treatments necessary to control a variety of species growing in the same ecosystem. It has been estimated that 75 percent of all water transpired by all plants is used by these low value species. Unfavorable climatic conditions during the grass establishment period following brush control and reinfestation by brush species are factors that often prevent effective control after the first treatment.

Another problem associated with the management of rangeland in the semiarid section of the study area is that of poor distribution of grazing as the result of inadequate cross fencing and inadequate water facilities.

A major problem associated with land use and management is the slow rate of planning and application of soil and water conservation measures on private land. Approximately 33 percent or 6.4 million acres of the agricultural land in the study area has received essential conservation treatment measures. Factors which hinder this effort are absentee ownership, short-term lease arrangements, influence of rapidly expanding urbanization and industrialization and speculative land buying.

Essential conservation practices are needed to protect and improve soil, water and plant resources. Table 3-11 shows the land which lacks this treatment.

TABLE 3-11

Land Inadequately Protected

Texas Coastal Basins

Land Use	Inadequately Protected -----(1000 Acres) ----
Cropland	3,100
Pastureland	1,800
Rangeland	5,300
Forest Land	2,400
Other Land	200
TOTAL	12,800

Source: CNI 1970

Forest Production

Although the growing stock volume of pine timber has increased from 3.3 billion cubic feet to 3.6 billion cubic feet in the last decade, the forest is still not as productive as it should be. Almost a quarter of a million acres of poorly stocked stands still exist in the area and they continue to hold down the true potential of the forest to produce quality wood products.

Half of the forest land in the study area is in private, non-industrial ownerships, much of it on an absentee basis. On these lands the net annual growth rate of timber products per acre is only half of that presently reached on industry and National Forest holdings. This low productivity is largely due to poor stocking of commercially valuable trees - a result of long-term abuse and neglect. The potential for timber production and environmental development are both high.

Overcoming this problem of poor stocking and growth will go a long way toward meeting the increasing demand for forest products both in the basin, regionally and nationally. Unless production is increased, an "economic shortage" is predicted about 1990: higher lumber prices, market dislocations, and priority changes are only some of the consequences of a supply-demand imbalance.

Poor utilization is another factor which further reduces the already low productivity of the small, individually-owned forests. An estimated 37 million cubic feet of raw material per year are lost during harvesting and land clearing operations. The losses during land clearing are especially high. Among the barriers to achieving a balanced and accelerated forest productivity in the basin are: the landowners' general ignorance of forest land capabilities and his various forest management options, conflicting land use objectives, limited time and money available for long-term investments. These and other pitfalls are compounded not only by the effects of having a small number of buyers of the timber products, but also by the present fragmented and distorted demands for the apparently less visible and less profitable uses such as water, wildlife habitat, dispersed recreation among others.

Other factors such as fire, insects, and diseases reduce growth or cause mortality. Southern Pine Beetle damage was considerable during the last 15 years as shown in Figure 3-2.

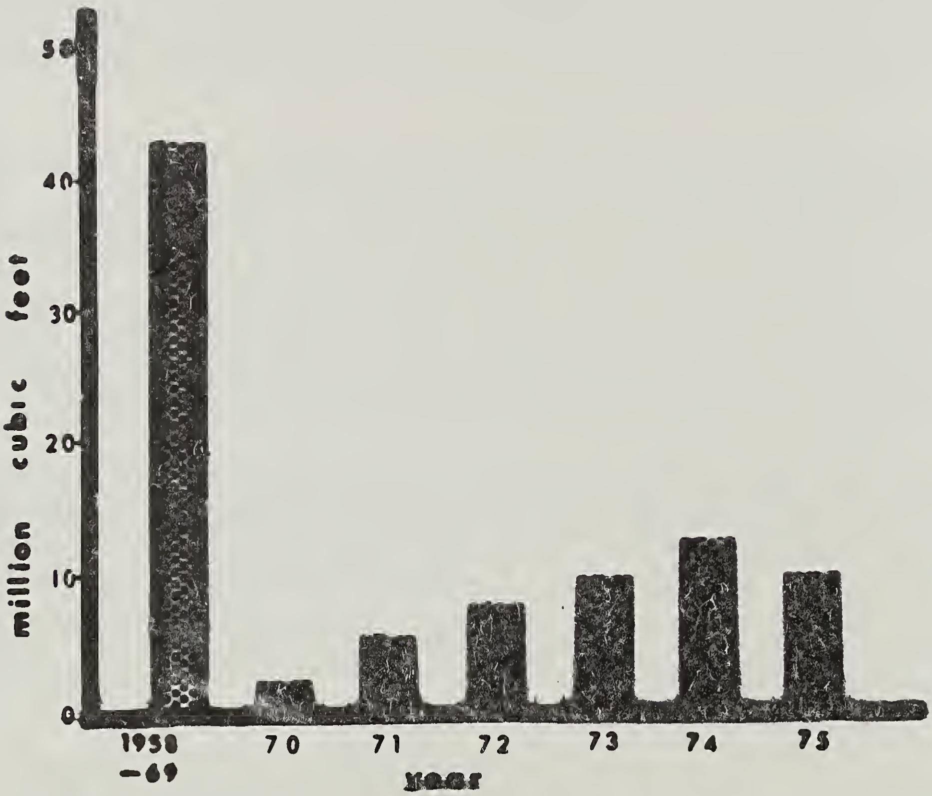
About three-fourths of the State's pine beetle damage is located within the basin area shown in Figure 3-3.

FIGURE 3-2

Southern Pine Beetle Losses

Texas Coastal Basins

(1958-1975)



Source: Forest Service, USDA, SA, S&PF

It is generally known that Southern Pine Beetle infestations are consistently more frequent and severe on poorly drained and overstocked sites. As trees grow and stocking increases, silvicultural treatments must be applied periodically to lessen the chances of outbreak in the poorly drained areas. The Texas Forest Service is emphasizing the utilization of beetle-killed timber as the primary method of suppressing beetle infestations. Unfortunately, trees in many infestations cannot be utilized because of their inaccessibility, size, quantity, and quality. Therefore, techniques other than salvage and expensive chemical treatments are needed.

Through an active control program, the Texas Forest Service has kept the loss small, about six percent of the total for all natural causes (Table 3-12). Continued efforts are needed to insure a future timber supply. Recent research indicates that most serious outbreaks of Southern Pine Beetle in pine forests

FIGURE 3-3

Southern Pine Beetle Infestation

Texas Coastal Basins

Source: Forest Service, USDA, SA, S&PF

can be prevented by keeping stands at the proper level of stocking. More efforts will be directed toward educating the landowner about the proper management techniques. It will be necessary to assist many small landowners in carrying out the needed management. This program can be achieved through existing legislation, but will require more personnel and accelerated funding.

Each year, fires burn an average of 8,100 acres. Most of these fires are small in size, usually less than 10 acres. The average forest land burn between 1970 and 1974 was 0.18 percent, which was well within the State watershed planning goal to keep the annual burn below 0.25 percent. Both the low burn percentage and small fire size can be attributed to the increased emphasis on detection and efficiency of fire crews and equipment in the State and national fire suppression organizations.

Fires within the basin destroy 2.3 million cubic feet of timber growing stock per year. Most destructive fires occur in the heavy fuel areas of the Piney Woods Region. Incendiary and debris burning caused two-thirds of all forest fires between 1970 and 1974. The highest incidence was from December through February. Statistics for the four-year period are excellent. However, weather history shows that some years bring high fire danger and high losses. When these high danger years occur, the Texas Forest Service has adequate organization, manpower, and equipment dispersed to execute effective suppression. Aerial detection is rapidly replacing tower detection.

TABLE 3-12

Annual Loss of Timber by Causes

Texas Coastal Basins

(1964)

Factors	Loss (Million Cubic Ft.)	Loss (Cubic Ft./Ac.)
Fire	2.3	0.52
Insects	1.4	0.30
Disease	3.2	0.73
Other	2.0	0.46
Unknown	15.7	3.53
All Causes	24.6	5.54

Source: Forest Service, USDA

Water Quality

Water quality problems can be classified as either natural or manmade. Natural problems occur usually as an excess of certain constituents which have been picked up by the water through contact with the ground. These include iron, silica, flouride, nitrate, chloride, sulfate, calcium, sodium, sediment, and organic materials. Manmade water quality problems are usually the result of the dumping or discharge of solid and liquid materials into natural water systems in such quantities that it is impossible for the assimilative properties of the system to degrade their toxic or esthetic effects to an unobjectionable level. The vast majority of the water quality problems in the study area are of manmade origin.

Municipal and industrial wastewater from waste treatment plants, urban runoff, and from sewage plants lowers the quality of the receiving streams. Some municipal and industrial waste treatment plants within the study area release effluent which is not completely treated and which has a high biochemical oxygen demand. This effluent also contains suspended and dissolved organic and inorganic materials which affect the quality of the water. Many wastewater treatment plants within the study area were not designed to treat the quantity of wastewater which now flows into the plant. Therefore, they are overloaded and at best can only provide an effluent which is partially treated. It is recognized that non-point pollution such as fertilizers, pesticides, and sediment occur within the basin; however, because of the difficulty of monitoring no attempt has been made to assess quantities.

Water quality of the river mainstems throughout the study area is good to excellent with the exception of the Brazos, San Antonio, and portions of the San Jacinto.

The San Antonio River is not presently suitable for contact recreation. Upon completion of proposed facilities the quality will be improved.

The San Jacinto River portion is not suitable for contact recreation or domestic raw water supply.

The Brazos River portion is not suitable for domestic raw water supply.

The poor quality is due to the fecal coliform content. The pollution sources in most cases originates beyond the study boundary.

Salt-water intrusion into the aquifer along the coast has degraded the quality of ground water in the Houston-Pasadena area.

Runoff from cattle feedlots pollutes the water in several streams within the study area. This type of waste has a high biochemical oxygen demand and creates anaerobic conditions which damage fish habitat and give off offensive odors.

Industrial waste is discharged into Nueces Bay along the south shore by industries lining the Corpus Christi ship channel. The paper and pulp processing mills in the eastern portion of the study area discharge treated waste into the watercourses.

In the San Jacinto River Basin, decay of natural vegetation in the densely forested northeastern part of the basin imposes an oxygen demand on several streams in this area and creates dissolved-oxygen depressions locally during summer months.

Low flows in the Nueces River Basin are relatively highly mineralized, principally as a result of irrigation return flows and the discharge of municipal wastewaters. The flow below Lake Corpus Christi is frequently saline as a result of inflow of saline ground water and drainage from oil field areas.

Under Public Law 92-500, Federal Water Pollution Control Act Amendments of 1972, it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985. The Environmental Protection Agency is charged with administering the Act. Also, the navigable waters have been interpreted by the courts to mean all waters of the United States.

Fish and Wildlife

The principal concerns associated with fish and wildlife management are loss and modification of habitat, pollution, deficient wildlife populations where there is good habitat, inadequate harvests due to limited access, and lack of incentives for private landowners to emphasize wildlife management in their agricultural operations.

Various segments of society place different values on fish and wildlife. The landowner may value these resources for the income he derives from hunting and fishing fees. To the sportsman fish and wildlife represent the opportunity to enjoy nature while in pursuit of his quarry. Others feel that wildlife are important for their contribution to esthetics and value to natural ecosystems. Some feel that fish and wildlife resources are subservient to technological progress. Plans for solving fish and wildlife problems must include compromises and trade-offs by all segments of society.

Habitat loss and modification in the bay systems and marshes affect both the fishing habitat and wetland wildlife habitat. Sediment is the product of erosion primarily from unprotected upland areas, streambanks, and construction sites. The sediment finds its way into coastal water bodies supplying essential nutrients, maintaining shoreline areas subject to erosive forces, and carrying materials toxic to fish, wildlife, and people. Dredging of channels and deposition of spoil can change the hydrologic characteristics of the area by partitioning a bay or otherwise altering current patterns.

A major problem is the loss of shallow nursery habitat caused by the construction of bulkheads and the subsequent filling of the area behind them. Also whenever areas subject to normal tidal inundation are leveed,making them non-tidal, valuable spawning and/or nursery areas for marine fishes and crustaceans are usually lost.

Salinity variations in wetlands and bays are greatly affected by freshwater inflow. Both extremes have been experienced in the Texas Coastal Basins. In the lower half of the coastal area where average annual rainfall is below 30 inches, high salinity due to reduced freshwater inflow is a problem. In the upper half of the coastal area excessive freshwater inflow has been responsible for occasional oyster die-off but such flows result in increased production in following years by supplying nutrient materials. Information is needed concerning the amount of timeliness of freshwater inflow to bays and estuaries. Industrial, domestic, and agricultural pesticide pollution results in losses of fishery resources by causing direct mortalities, decreased reproductive potential or by rendering them unfit for consumption.

Upland wildlife habitat modification and loss can be attributed to technological advances of man. Land is cleared of woody vegetation to make way for more improved plant species. Wildlife may be severely affected if a monoculture results which furnishes little wildlife food and cover.

Industrialization and subdivision of large rural tracts of land for country homesites have placed additional pressure on wildlife habitat. The mere presence of people forces the migration of some wildlife species to other areas. Many times homesites along streams and lakes are also preferred wildlife areas. Wildlife populations within the sphere of influence of these developments are also affected.

Pollution of water areas in the Texas Coastal Basins has resulted in the degradation of the fishery resource. In volume sediment is the prime pollutant in inland water bodies. Industry, ships, cities, and towns find it convenient to dump wastes into water areas. Chemicals and fertilizers from agricultural operations also contribute to the pollution problems.

Game populations are below their potential in the forest land of the upper coastal wildlife habitat due primarily to poor distribution of food plants, difficulty in enforcing game regulations, and lack of appreciation for sound wildlife management practices and techniques.

Wildlife management on a broad scale is far from simple. This has resulted in wildlife populations fluctuating from high to low or none depending upon the area and habitat. The enforcement of game laws pertaining to seasons and bag limits is difficult to achieve in some areas. In other areas where enforcement is not a limiting constraint, proper hunting regulations and harvest methods have not produced expected results. A breakdown in communication between landowners and wildlife officials, in matters pertaining to management practices, harvest methods and numbers to be harvested, has also decimated game populations in some locations. Multiple land use based only on immediate economic return results in wildlife receiving the least emphasis in mangement practices. Intensive use of the land as cropland, pastureland, or rangeland often brings about degradation of wildlife habitat.

Preservation of Archeological and Historical Resources

The Texas Coastal Basins has been the scene of a large share of Texas' significant historical events. There is increased public interest in the State and the study area in the preservation of archeological and historical sites. Thus far in the study area 2,997 sites have been recorded of which 2,678 are archeological and 319 are historical. Many other sites are expected to be found in the future and should be assessed.

OBJECTIVES

The Principles and Standards specify that the overall purpose of water and land resource planning will be directed toward improvement in the quality of life through contribution to two major objectives:

1. National Economic Development (NED) - to enhance national economic development by increasing the value of the Nation's output of goods and services and improving national economic efficiency.

2. Environmental Quality (EQ) - to enhance environmental quality by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

SPECIFIC COMPONENTS

The problems or study concerns were translated into specific components of NED and EQ objectives. Specific components refer to the desired goals of goods and services, and environmental conditions being sought as contribution to NED and EQ. The components are expressed in terms of outputs (beneficial effects); never in terms of inputs to the plan.

Just as the problems were identified by public involvement, specific components are publicly expressed as desires and preferences.

First Level (Desires)

The first level of specific components are directly related to the NED objective as to kind of actual outputs of goods and services desired, and directly expressed to the EQ objective as the creation, management, or preservation of the natural physical-biological system.

Second Level (Preferences)

The second level of specific components for the NED objective is the translation of the first level for goods and services into specific needs for water and land resources.

The second level of specific components for EQ objective is expressed directly in terms of preferred environmental conditions.

Table 3-13 shows the relationship between objectives, problems, and specific components.

TABLE 3-13

Problems and Objectives

Texas Coastal Basins

PRIMARY OBJECTIVE	PROBLEMS (PUBLIC CONCERNS)	SPECIFIC COMPONENTS OF THE OBJECTIVES	
		FIRST LEVEL (DESIRES)	SECOND LEVEL (PREFERENCES)
NATIONAL ECONOMIC DEVELOPMENT	1. a. Frequent Flood Damage to Rural Areas	Increase or More Efficient Output of Food and Fiber	Reduce Floodwater and Related Damages
	b. Frequent Flood Damage to Urban and Built-up Area	Improve Living and Working Conditions	Reduce Flood Hazard
	2. Frequent Crop Damage Due to Poor Drainage	Increased or More Efficient Output of Food and Fiber	Reduce Crop Damage Due to Poor Drainage
	3. Limited Supply of Water for Irrigation Use	Increased or More Efficient Output of Food and fiber	Opportunities for More Efficient Use of Existing Water Supplies and Developing Additional Irrigation Supplies
	4. Limited Recreational Opportunities	Increase or Improve Recreational Services	Provision for Water and Related Land Recreation Opportunities

TABLE 3-13 (cont'd)

Problems and Objectives

Texas Coastal Basins

PRIMARY OBJECTIVE	PROBLEMS (PUBLIC CONCERNS)	SPECIFIC COMPONENTS OF THE OBJECTIVES	
		FIRST LEVEL (DESIRES)	SECOND LEVEL (PREFERENCES)
NATIONAL ECONOMIC DEVELOPMENT (continued)	5. Damages from Erosion	Maintain Productivity of the Land and Water	Provisions for Reducing Erosion
	6. Damages from Sedimentation	Reduce Sediment in Streams, Rivers, Lakes, etc.	Provisions for Reducing Sediment
	7. Inadequate Land Treatment	Maintain and Improve Productivity and Use of the Land	Accelerate application of conservation and management measures
	8. Forestry Resource Shortages	Increased or More Efficient Output of Forest Products	Reduce Forest Losses and improve forest stocking
ENVIRONMENTAL QUALITY	1. Limited and Declining Fish and Wildlife Habitat	Increase, Protect and Improve Fish and Wildlife Habitat	Opportunities to Increase, Protect, and Improve Fish and Wildlife Habitat

TABLE 3-13 (cont'd)

Problems and Objectives

Texas Coastal Basins

PRIMARY OBJECTIVE	PROBLEMS (PUBLIC CONCERNS)	SPECIFIC COMPONENTS OF THE OBJECTIVES	
		FIRST LEVEL (DESIRES)	SECOND LEVEL (PREFERENCES)
ENVIRONMENTAL QUALITY (continued)	2. Damage from Erosion	Improve Quality of Land and Water	Provisions for Reducing Erosion
	3. Damage from Sediment	Improve Quality of Land and Water	Provisions for Reducing Sediment
	4. Damage to archeological and historical resources	Preservation of archeological and historical resources	Protection of archeological and historical sites

Source: River Basin Staff

RESOURCE BASE

TEXAS COASTAL BASINS

CHAPTER 4

RESOURCE BASE

LOCATION

The Texas Coastal Basins study area, as shown on Plate 4-1 is located entirely within the State of Texas and includes all of 24 counties and portions of 22 additional counties.

The area borders the Gulf of Mexico and includes all of the coastal basins and intervening areas between the Lower Rio Grande Valley and the Sabine River Basin. Also included are: the Nueces River from its mouth to gaging station 8-2100 at Three Rivers; the San Antonio River from its mouth to gaging station 8-1885 on U.S. Highway 183 at Goliad; the Guadalupe River from its mouth to gaging station 8-1758 on U.S. Highway 77A at Cuero; the Colorado River from its mouth to gaging station 8-1610 on U.S. Highway 90 at Columbus; the Brazos River from its mouth to gaging station 8-1102 on State Highway 90 near Navasota, except the Navasota River; the Trinity River from its mouth to the Livingston dam site; and the Neches River from its mouth to B.A. Steinhagen Reservoir.

The study area is about 380 miles long and averages 70 miles wide and includes about 20,733,400 acres of land and 1,577,500 acres of water bodies over 40 acres in size, most of which is salt water in the bays and estuaries. It lies at the lower end of the Texas Gulf Region as defined by the Water Resources Council.

Seven major rivers cross the study area enroute to the sea. These rivers have meandering courses with many loops and curves. Most all of the streams and rivers exhibit dendritic drainage patterns and flow in a southeasterly direction to the Gulf of Mexico.

CLIMATE

The climate is generally subtropical with long, warm to hot summers and short, mild winters. Average annual rainfall, as shown on the rainfall map, Plate 4-2, ranges from 26 inches at

Kingsville to 55 inches at Beaumont. The average annual temperature ranges from about 70 degrees at Beaumont to 74 degrees at Corpus Christi. The average length of the growing season varies from 241 days in Tyler County to 319 days in Kenedy County.

GEOLOGY

The geology of the basin is dominated by sedimentary formations, ranging in age from late Eocene to Recent, cropping out in bands nearly parallel with the coast. The youngest deposits border the Gulf and successively older beds crop out toward the interior. In vertical section, Figure 4-1, geologic formations underlying the study area occur as a series of gently dipping, truncated wedges that thicken towards the coast. The most inland and oldest formations were deposited about 56 million years ago. At this time the shoreline lay about 110 miles inland of its present position. Since that time there has been continual rising of the continental land mass and subsidence of the offshore area resulting in a retreat of the shoreline to its present position.

The geologic time scale, Table 4-1, shows the relationship and relative ages of the geologic units shown on Plate 4-3. Also shown on this table are intervals during which erosion (valley cutting), rather than deposition, was occurring.

TOPOGRAPHY

The basin topography, Plate 4-4, is characterized by the gentle rise in elevation from sea level at the coast to the interior basin boundary. The contours generally parallel the coast except where they turn upstream to depict the river and stream valleys. Approximately half of the study area lies between sea level and 100 feet in elevation. This area is flat, nearly featureless, coastal marsh and prairie. The only noticeable topographic features are the rivers and stream channels and infrequent slight hills or mounds marking the presence of buried salt plugs. Above the 100-foot elevation, the topography becomes rolling with the relief increasing in the landward direction and becoming moderately rolling in the most inland portions. All of the streams and rivers flow in a generally southeasterly direction to the bays and estuaries and the Gulf of Mexico. The highest elevation in the study area is in Webb County. Actually, only a small part of the basin lies above 500 feet in elevation.

Plate 4-1

TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

May 1971 4-R-30440

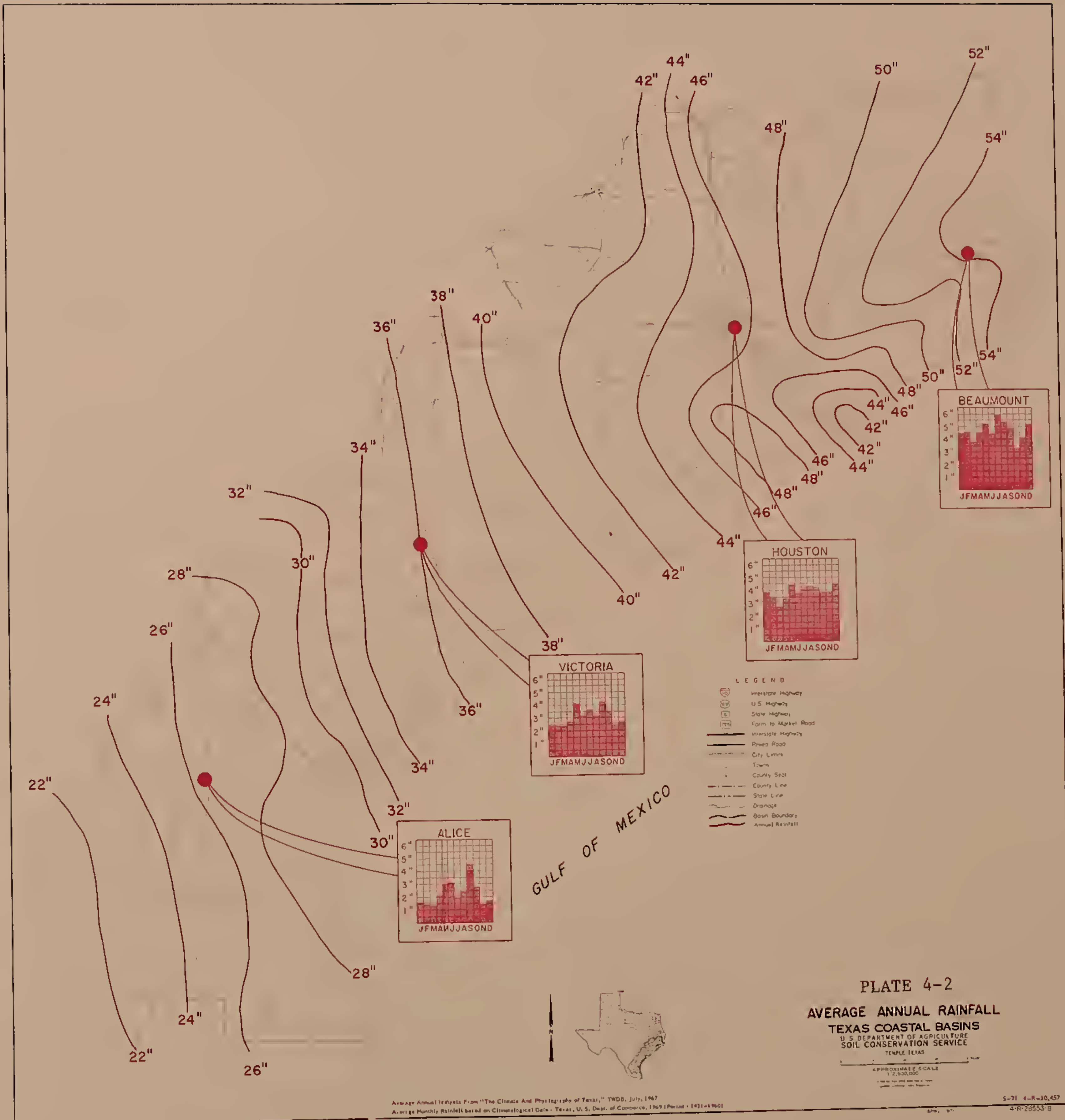


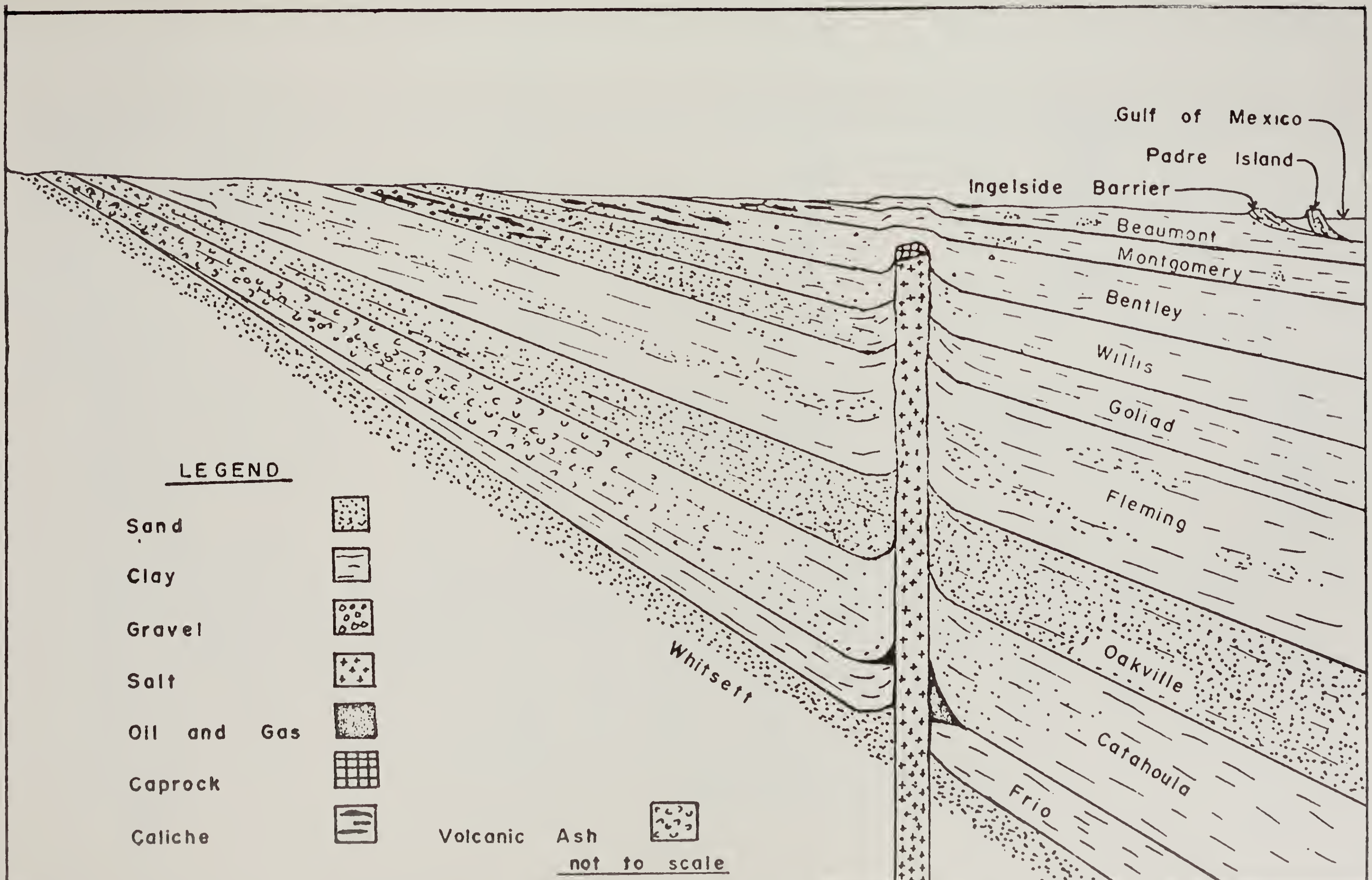
PLATE 4-2

AVERAGE ANNUAL RAINFALL
TEXAS COASTAL BASINS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS

FIGURE 4-1

Generalized Geologic Cross Section

Texas Coastal Basins



Source: River Basin Staff, SCS

Geologic Time Scale

Texas Coastal Basins

System	Series	Years Before Present	Unit or Interval	
Quaternary	Recent		Alluvium	
			Barrier Island	
		20,000	Sand Sheet	
	Recent or late (?) Pleistocene	40,000	Deweyville	
	Pleistocene	62,000	Valley Cutting	
		100,000	Beaumont	←Fluviatile terraces→
		160,000	Valley Cutting	
			Montgomery	
		290,000	Montgomery-Bentley	
		350,000	Valley Cutting	
		670,000	Bentley	
		740,000	Valley Cutting	
			*Qwc — Willis	
		1 Million	*Qwl — Willis	
Tertiary	Pliocene		Valley Cutting	
		12 Million	Goliad	
	Miocene		Fleming	
			Oakville	
		26 Million	Catahoula	
	Oligocene	37 Million	Non-deposition	
	Eocene	54 Million	Whitsett	

Sources: (1) Hugh A. Bernard, Rufus J. Leblanc, "Resume of the Quaternary Geology of the Northwestern Gulf of Mexico Province", 1965.
(2) United States Department of Interior, Geological Survey, "Geologic Time", 1970.
* See legend on Plate 4-3.

SOILS

The soils in the basin range from deep, rapidly permeable, excessively drained sands to deep, very slowly permeable, very poorly drained clays. Some have sandy or loamy surface layers underlain by blocky clay layers. Others are saline, sandy coastal soils which are flooded by storm tides and eroded by winds. Some are sticky, wet, saline clays of the marshes, and a few have a gravelly surface layer and caliche in the subsoil.

A general soil map of the basin is shown as Plate 4-5. The line and symbol delineations on this map show important soil associations. The area within the delineations of a soil association is occupied by two or more series of major extent and several series of lesser extent.

There are 55 soil associations in the Texas Coastal Basins study area. These associations have been placed into 15 groups based on generalized similarities which are described in the map legend. Table 4-2 shows the acreage in these groups. These are colored on the map.

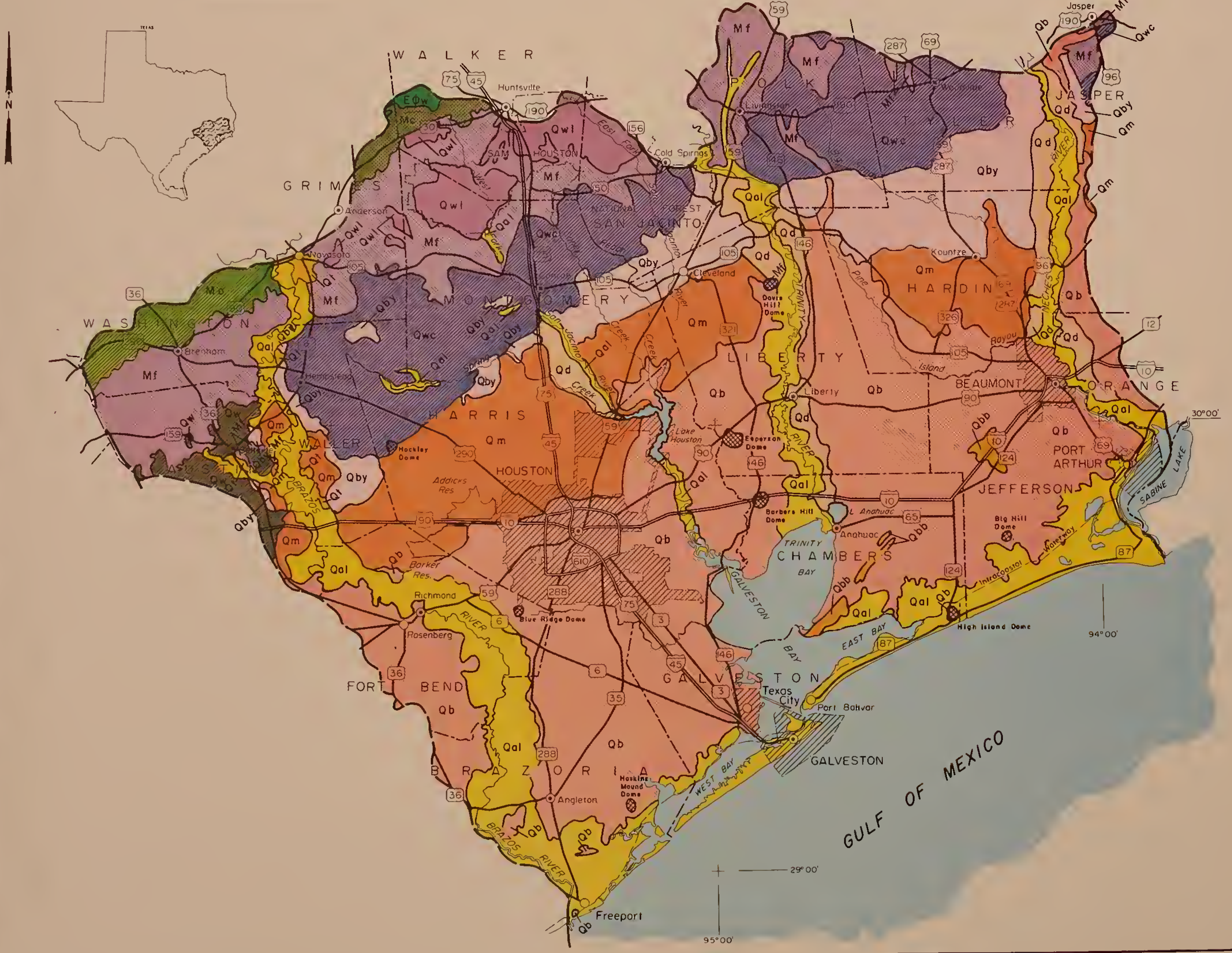
LAND RESOURCE AREAS

The study area is composed of six land resource areas: Rio Grande Plain (83), Texas Blackland Prairie (86), Texas Claypan Area (87), Southern Coastal Plain (133), Gulf Coast Prairies (150), and Gulf Coast Marsh (151), (Plate 4-6). A land resource area (LRA) is a geographical area charactreized by similarities of soil, topography, climate, and vegetation.

LAND BASE

Current land use is divided into eight major use categories: cropland, pastureland, rangeland, forest land, other land, urban built-up, Federal land, and water. Subuses can be applied to the various major uses. Federal lands include refuges, parks, reservations, and forests.

About 87 percent of the 22,310,900-acre basin is agricultural and forest land, with only 13 percent being non-agricultural. Table 4-3 shows the current land use distribution.



EXPLANATION

ERA	SYSTEM	SERIES	FORMATION	LITHOLOGY	SYMBOL
Cenozoic	Quaternary	Recent	Alluvium	Clay, silt, sand, and gravel, organic matter abundant locally, includes point bar, natural levee, stream channel, backswamp, coastal marsh, mud flat, "clay" dune, sand dune, and oyster reef deposits along the bay, estuary and ocean shores. Includes flood plain deposits along major rivers such as point bars, oxbows, and abandoned channel segments. Includes older deposits exposed in pits in flood plain of Guadalupe River in vicinity of Victoria, also some small terrace deposits along streams other than the Nueces River	Qal
		Recent or late (?) Pleistocene	Deweyville Formation	Sand, silt, and clay, some gravel, includes point bar, natural levee, stream channel, and backswamp deposits at a level only slightly above that of the present flood plain, sand coarser than in alluvium, surface characterized by relict meanders of much larger radius of curvature than those of present streams, some scattered pimple mounds, thickness locally more than 50 feet. High level Deweyville surfaces cut in the Beaumont Formation and high level Deweyville deposits along Trinity River are intermediate in position between the Beaumont surface and the level of most Deweyville deposits, along the Guadalupe and San Antonio Rivers bounded in many places by scarps cut in Beaumont clay.	Qd
		Pleistocene	Beaumont Formation	Beaumont Formation, Qb, with barrier island and beach deposits, Qbb, mapped separately. Beaumont Formation, Qb, mostly clay, silt, sand and gravel, includes mainly stream channel, point bar, natural levee, and backswamp deposits, and to a lesser extent, coastal marsh, mud flat, lagoonal, Recent and older lake, "clay" dune, and sand dune deposits, gravel deposits mostly along Guadalupe River in vicinity of Victoria, concentrations and massive accumulations of calcium carbonate ("caliche"), and concentrations of iron oxide and iron-manganese oxides in zone of weathering, surface almost featureless east of Guadalupe River with poorly defined meander belt ridges (with many pimple mounds especially towards eastern edge of map area) separated by relatively smooth featureless backswamp deposits, west of Guadalupe River surface pitted by shallow lakes or dry lake beds with associated "clay" dunes, which in places, align along meander belt ridges, pimple mounds only in vicinity of Qbb unit, thickness 100' feet. Barrier island and beach deposits, Qbb, mostly fine-grained sand, shells scarce, surface slightly higher than that of surrounding deposits, characterized by numerous pimple mounds, and poorly defined relict beach ridges, includes many Recent, locally active, sand dunes, probably part of "Ingleside" barrier island system, thickness less than 60 feet.	Qbb Qb
			Montgomery Formation	Clay, silt, sand, and gravel, locally calcareous with concretions and massive accumulations of calcium carbonate ("caliche") and concretions of iron oxide and iron-manganese oxides in zone of weathering, gravel most abundant along Guadalupe River, fluviatile, surface flat and featureless except for numerous rounded depressions which west of Guadalupe River are larger and associated with Recent "clay" dune deposits, thickness 100' feet. (Upper part of Lissie Formation as previously mapped)	Qm
			Bentley Formation	Clay, silt, sand, and gravel, locally calcareous with concretions and massive accumulations of calcium carbonate ("caliche"), concretions of iron oxide and iron-manganese oxides in zone of weathering more abundant than in Montgomery formation, gravel most abundant along Guadalupe River and coarser than in Montgomery Formation, fluviatile, surface featureless except for numerous large rounded depressions which west of Guadalupe River are associated with Recent "clay" dune deposits, thickness 100' feet. (Lower part of Lissie Formation as previously mapped)	Qby
			Fluviatile terraces undivided	Clay, silt, sand, gravel, and "caliche," in deposits along valley walls, probably in large part correlatives of Deweyville, Beaumont, Montgomery, Bentley, and Willis deposits, may include some terraces cut in older rocks.	Ql
			Willis Formation	Clay, silt, sand, and siliceous gravel of granule to pebble size, including some petrified wood, sand coarser than in younger units, noncalcareous, mostly deeply weathered and lateritic, indurated by clay and cemented by iron oxide locally, iron oxide concretions abundant and locally used as road material in coastward belt of outcrop, Qwc, iron oxide concretions less abundant and amount of weathering decreases eastward in landward belt of outcrop, Qwl, coastward edge of base of Qwl outcrop is mostly at a lower elevation than base of landward edge of Qwc, indicating that the two outcrop belts may be of different ages, forms scarps on landward side, west of Brazos River undivided, Qw, fluviatile, thickness 100' feet. (Williana Formation is a more recent name for deposits in Louisiana equivalent to the Willis Formation in Texas)	Qwc Qwl
	Tertiary	Miocene	Fleming Formation	Clay and sandstone, clay is commonly calcareous and forms brownish-black soil. Sandstone is medium grained, calcareous, thick, bedded, some cross-bedding, light yellowish-gray to light gray; weathers light gray to medium gray, locally red beneath Willis. Some quartz and chert pebbles, fossil wood, and vertebrate fossils common locally, thickness 1,300-1,450 feet.	Mf
			Oakville Sandstone	Sandstone and clay, sandstone is medium grained, calcareous, light yellowish-gray to light gray, thick bedded, some cross-bedding, locally contains fossil wood, quartz and chert gravel and reworked Cretaceous vertebrate fossils, invertebrate fossils. Clay is calcareous, yellowish-gray and forms cuesta of smoothly rounded hills, thickness 300-500 feet.	[illegible]
			Catahoula Formation	Clay and sand. Clay is bentonitic, noncalcareous except for some calcareous concretions locally, light olive gray. Sand is fine to medium grained tuffaceous, cross-bedded lenses, gray, thickness 350' feet.	[illegible]
		Eocene	Whitsett Formation	Quartz sand, fine to medium grained, tuffaceous, lignitic, argillaceous, locally silica cemented, light gray to dark gray laminations, fossil wood common, thickness 75-130 feet.	[illegible]

Note This map is preliminary in nature and is valid only until publication of the Austin, Seguin, and Beeville-Bay City sheets of the Geologic Atlas of Texas. Preliminary compilation, Geologic Atlas of Texas, Bureau of Economic Geology, The University of Texas at Austin, Virgil E. Barnes, Project Director.

PLATE 4-3

GEOLOGIC MAP
TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

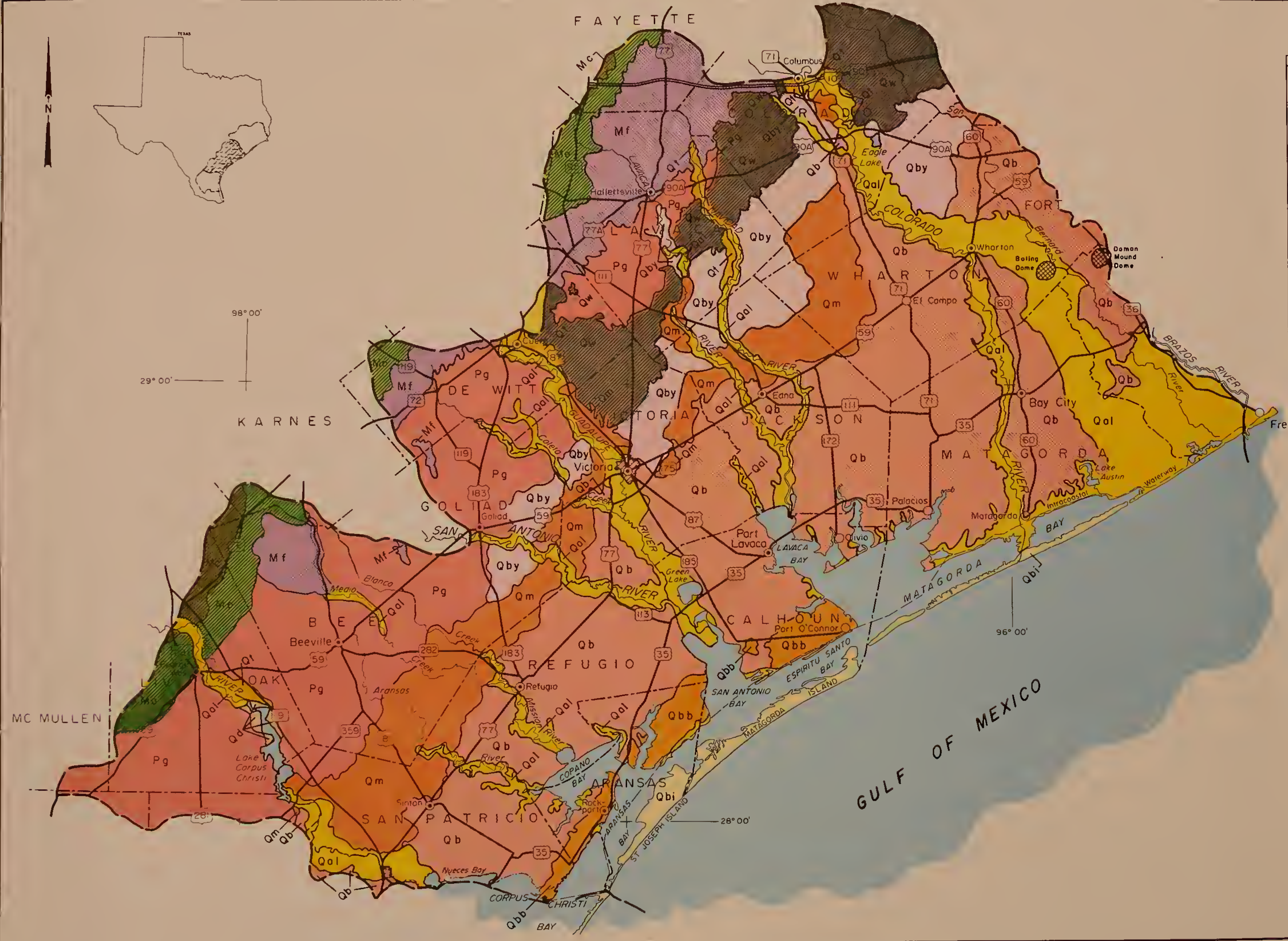
0 10 20 30 40 MILES
APPROXIMATE SCALE
1:1,000,000 or 1 inch = 15.78 miles

Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection

Sheet 1 of 3 4-R-30,526

USDA-SCS-FORT WORTH, TEX. 1971

May 1971 4-R-28553C



EXPLANATION

ERA	SYSTEM	SERIES	FORMATION	LITHOLOGY	SYMBOL
Cenozoic	Quaternary	Recent	Alluvium	Clay, silt, sand, and gravel, organic matter abundant locally, includes point bar, natural levee, stream channel, backswamp, coastal marsh, mud flat, "clay" dune, sand dune, and oyster reef deposits along the bay, estuary and ocean shores. Includes flood plain deposits along major rivers such as point bars, oxbows, and abandoned channel segments. Includes older deposits exposed in pits in flood plain of Guadalupe River in vicinity of Victoria, also some small terrace deposits along streams other than the Nueces River.	Qal
			Barrier Island Deposits	Sand, silt and clay, mostly sand, well sorted, fine grained, abundant shells and shell fragments interfingers with silt and clay in landward direction, includes beach ridge, spit, tidal channel, tidal delta, washover fan, and sand dune deposits.	Qbi
		Recent or late (?) Pleistocene	Deweyville Formation	Sand, silt, and clay, some gravel, includes point bar natural levee, stream channel, and backswamp deposits at a level only slightly above that of the present flood plain, sand coarser than in alluvium, surface characterized by relict meanders of much larger radius of curvature than those of present streams, some scattered pimple mounds, thickness locally more than 50 feet. High level Deweyville surfaces cut in the Beaumont Formation and high level Deweyville deposits along Trinity River are intermediate in position between the Beaumont surface and the level of most Deweyville deposits, along the Guadalupe and San Antonio Rivers bounded in many places by scarps cut in Beaumont clay.	Qd
		Pleistocene	Beaumont Formation	Beaumont Formation, Qb, with barrier island and beach deposits, Qbb, mapped separately. Beaumont Formation, Qb, mostly clay, silt, sand and gravel, includes mainly stream channel, point bar, natural levee, and backswamp deposits, and to a lesser extent, coastal marsh, mud flat, lagoonal, Recent and older lake, "clay" dune, and sand dune deposits, gravel deposits mostly along Guadalupe River in vicinity of Victoria; concretions and massive accumulations of calcium carbonate ("caliche"), and concretions of iron oxide and iron-manganese oxides in zone of weathering, surface almost featureless east of Guadalupe River with poorly defined meander belt ridges (with many pimple mounds especially towards eastern edge of map area) separated by relatively smooth featureless backswamp deposits, west of Guadalupe River surface pitted by shallow lakes or dry lake beds with associated "clay" dunes, which in places, align along meander belt ridges, pimple mounds only in vicinity of Qbb unit, thickness 100' feet. Barrier island and beach deposits, Qbb, mostly fine-grained sand, shells scarce, surface slightly higher than that of surrounding deposits, characterized by numerous pimple mounds, and poorly defined relict beach ridges, includes many Recent, locally active, sand dunes; probably part of "Ingleside" barrier island system, thickness less than 60 feet.	Qbb Qb
			Montgomery Formation	Clay, silt, sand, and gravel, locally calcareous with concretions and massive accumulations of calcium carbonate ("caliche") and concretions of iron oxide and iron-manganese oxides in zone of weathering, gravel most abundant along Guadalupe River, fluviatile; surface flat and featureless except for numerous rounded depressions which west of Guadalupe River are larger and associated with Recent "clay" dune deposits, thickness 100' feet. (Upper part of Lissie Formation as previously mapped)	Qm
			Bentley Formation	Clay, silt, sand, and gravel, locally calcareous with concretions and massive accumulations of calcium ("caliche"), concretions of iron oxide and iron-manganese oxides in zone of weathering more abundant than in Montgomery formation, gravel most abundant along Guadalupe River and coarser than in Montgomery Formation, fluviatile, surface featureless except for numerous large rounded depressions which west of Guadalupe River are associated with Recent "clay" dune deposits, thickness 100' feet. (Lower part of Lissie Formation as previosuly mapped)	Qby
			Fluviatile terraces undivided	Clay, silt, sand, gravel, and caliche," in deposits along valley walls, probably in large part correlatives of Deweyville, Beaumont, Montgomery, Bentley, and Willis deposits, may include some terraces cut in older rocks.	Qt
			Willis Formation	Clay, silt, sand, and siliceous gravel of granule to pebble size, including some petrified wood, sand coarser than in younger units, noncalcareous, mostly deeply weathered and lateritic, indurated by clay and cemented by iron oxide locally, fluviatile, thickness 100' feet. (Williana Formation is a more recent name for deposits in Louisiana equivalent to the Willis Formation in Texas.)	[illegible]
	Tertiary	Pliocene	Goliad Formation	Clay, sand, sandstone, marl, caliche, limestone, and conglomerate. Clay is commonly light shades of pink or green with calcareous concretions. Sand and sandstone are medium to very coarse grained, in part cross-bedded, mostly quartz, some black and red chert. Conglomerate is black chert and dark siliceous granules and pebbles in calcareous ("caliche") matrix. Sandstone and conglomerate are locally well bedded. Marl and limestone are poorly bedded or massive, Tertiary vertebrate and reworked Cretaceous invertebrate fossils fairly common, thickness 75-200 feet, thins northeastword. Partially obscured locally by Willis or Willis-like deposits of coarse gravel less than 2 feet thick. A featureless, deeply weathered area northeastward from Mathis may represent a Bentley surface cut on Goliad. Other similar areas which have not been outlined may represent either Bentley or Willis cut surfaces.	Pg
		Miocene	Fleming Formation	Clay and sandstone, clay is commonly calcareous and forms brownish-black soil. Sandstone is medium grained, calcareous, thick bedded, some cross-bedding, light yellowish-gray to light gray, weathers light gray to medium gray, locally red beneath Willis. Some quartz and chert pebbles, fossil wood, and vertebrate fossils common locally, thickness 1,300-1,450 feet.	Mf
			Oakville Sandstone	Sandstone and clay; sandstone is medium grained, calcareous, light yellowish-gray to light gray, thick bedded, some cross-bedding, locally contains fossil wood, quartz and chert gravel and reworked Cretaceous vertebrate fossils, invertebrate fossils. Clay is calcareous, yellowish-gray and forms cuesta of smoothly rounded hills, thickness 300-500 feet.	[illegible]
			Catahoula Formation	Clay and sand, Clay is bentonitic, noncalcareous except for some calcareous concretions locally, light olive gray. Sand is fine to medium grained tuffaceous, cross-bedded lenses, gray, thickness 350' feet.	[illegible]

Note: This map is preliminary in nature and is valid only until publication of the Seguin, Crystal City, Beeville-Bay City, Laredo, and Corpus Christi sheets of the Geologic Atlas of Texas. Preliminary compilation, Geologic Atlas of Texas, Bureau of Economic Geology, The University of Texas at Austin, Virgil E. Barnes, Project Director.

PLATE 4-3

GEOLOGIC MAP TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

0 10 20 30 40 MILES
APPROXIMATE SCALE
1:1,000,000 or 1 inch = 15.78 miles

Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection

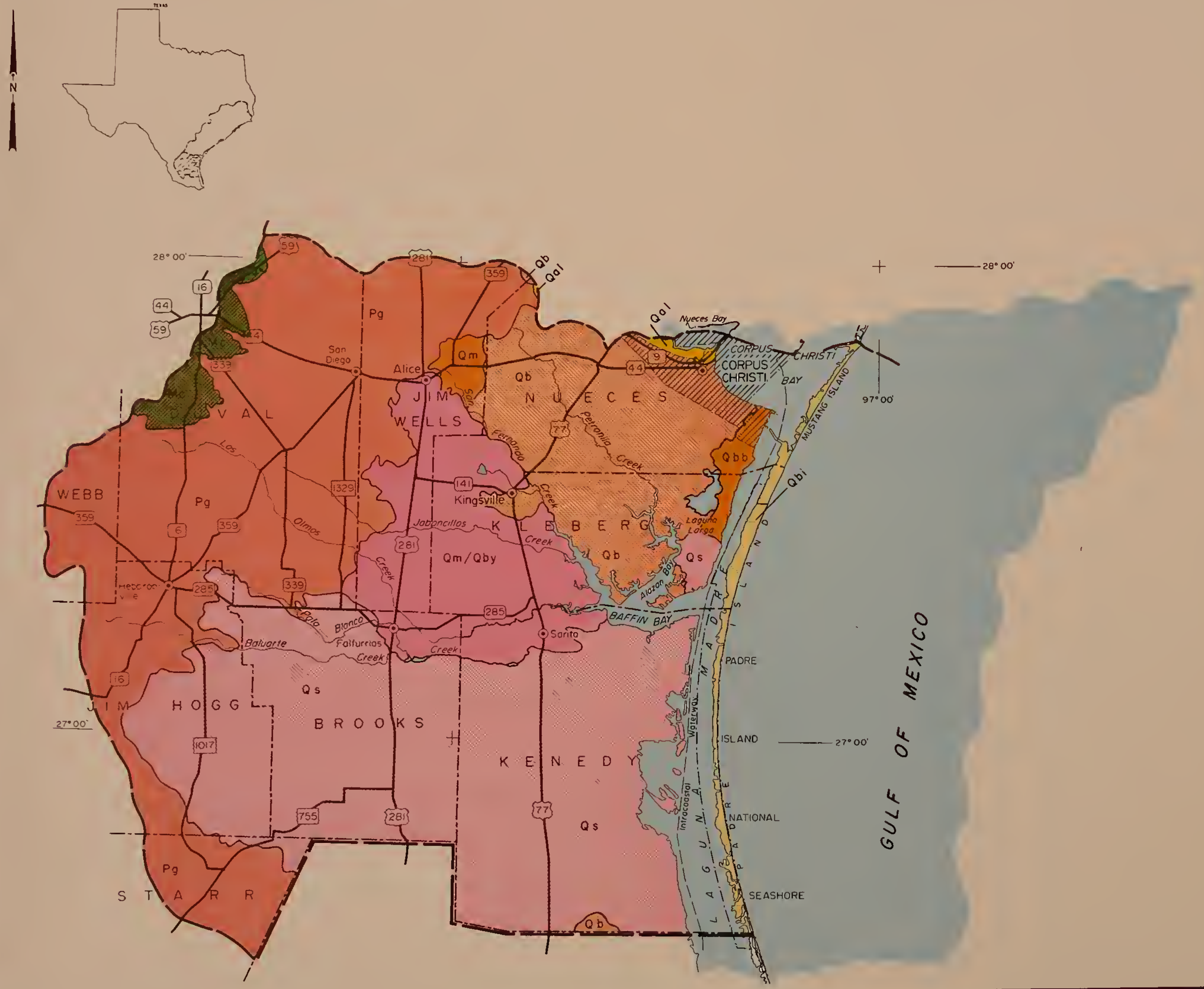
Sheet 2 of 3

4-R-30,526

May 1971

4-R-28553C

USDA-SCS FORT WORTH TEX 1971



EXPLANATION

ERA	SYSTEM	SERIES	FORMATION	LITHOLOGY	SYMBOL
Cenozoic	Quaternary	Recent	Alluvium	Clay, silt, sand, and gravel, organic matter abundant locally, includes point bar, natural levee, stream channel, backswamp, coastal marsh, mud flat, "clay" dune, sand dune, and oyster reef deposits along the bay, estuary and ocean shores. Includes flood plain deposits along major rivers such as point bars, oxbows, and abandoned channel segments. Includes older deposits exposed in pits in flood plain of Guadalupe River in vicinity of Victoria, also some small terrace deposits along streams other than the Nueces River.	Qal
			Barrier Island deposits	Sand, silt and clay; mostly sand, well sorted, fine grained, abundant shells and shell fragments, interfingers with silt and clay in landward direction, includes beach ridge, spit, tidal channel, tidal delta, washover fan, and sand dune deposits.	Qbi
			Sand Sheet Deposits	Fine to medium sand, silt and clay. Sand mostly in longitudinal northwest trending dunes. Includes recently and currently active dunes as well as dunes apparently stable since late Pleistocene times. Includes playa lake deposits, "clay" dunes in vicinity of playa lakes, recently cemented (calcified) sand as well as "caliche" deposits of Bentley or Goliad age under thin sand cover. Includes narrow beach deposits along the southern shore of Baffin Bay and local stream deposits. Boundaries with other mapping units indistinct, based mainly on southern limit of recently stabilised or currently active dunes.	Qs
		Pleistocene	Beaumont Formation	Beaumont Formation, Qb, with barrier island and beach deposits, Qbb, mapped separately. Beaumont Formation, Qb, mostly clay, silt, sand and gravel, includes mainly stream channel, point bar, natural levee, and backswamp deposits, and to a lesser extent, coastal marsh, mud flat, lagoonal, Recent and older lake, "clay" dune, and sand dune deposits; gravel deposits mostly along Guadalupe River in vicinity of Victoria, concretions and massive accumulations of calcium carbonate ("caliche"), and concretions of iron oxide and iron-manganese oxides in zone of weathering; surface almost featureless east of Guadalupe River with poorly defined meander belt ridges (with many pimple mounds especially towards eastern edge of map area) separated by relatively smooth featureless backswamp deposits, west of Guadalupe River surface pitted by shallow lakes or dry lake beds with associated "clay" dunes, which in places align along meander belt ridges, pimple mounds only in vicinity of Qbb unit, thickness 100' feet. Barrier island and beach deposits, Qbb, mostly fine-grained sand, shells scarce, surface slightly higher than that of surrounding deposits, characterized by numerous pimple mounds, and poorly defined relict beach ridges, includes many Recent, locally active, sand dunes, probably part of "Ingleside" barrier island system; thickness less than 60 feet.	Qbb Qb
			Montgomery Formation	Clay, silt, sand, and gravel, locally calcareous with concretions and massive accumulations of calcium carbonate ("caliche") and concretions of iron oxide and iron-manganese oxides in zone of weathering, gravel most abundant along Guadalupe River, fluviatile, surface flat and featureless except for numerous rounded depressions which west of Guadalupe River are larger and associated with Recent "clay" dune deposits, thickness 100' feet. (Upper part of Lissie Formation as previously mapped)	Q
			Montgomery and Bentley Formations Undivided	Clay, silt, and sand, concretions of calcium carbonate common in zone of weathering. "caliche" deposits largely absent in eastern part of the outcrop area, except in area south of Kingsville and east of Ricardo where over 20 feet of laminated to thin bedded, friable, calcium carbonate cemented sand, silt, and marls as well as nodular and massive "caliche". Surface characterized by many rounded to irregular depressions and irregular isolated hills. Includes poorly defined and patchy areas of recent alluvium (fluviatile), thin (less than 3 feet thick) or discontinuous wind-blown and Recent "clay" dunes, especially in the vicinity of saline lakes.	Qm/Qby
	Tertiary	Pliocene	Goliad Formation	Clay, sand, sandstone, marl, caliche, limestone, and conglomerate. Clay is commonly light shades of pink or green with calcareous concretions. Sand and sandstone are medium to very coarse grained, in part cross-bedded, mostly quartz, some black and red chert. Conglomerate is black chert and dark siliceous granules and pebbles in calcareous ("caliche") matrix. Sandstone and conglomerate are locally well bedded. Marl and limestone are poorly bedded or massive. Tertiary vertebrate and reworked Cretaceous invertebrate fossils fairly common; thickness 75-200 feet, thins northeastward. Partially obscured locally by Willis or Willis-like deposits of coarse gravel less than 2 feet thick. A featureless deeply weathered area northeastward from Mathis may represent a Bentley surface cut on Goliad. Other similar areas which have not been outlined may represent either Bentley or Willis cut surfaces.	Pg
		Miocene	Oakville Sandstone	Sandstone and clay, sandstone is medium grained, calcareous, light yellowish-gray to light gray, thick bedded, some cross-bedding, locally contains fossil wood, quartz and chert gravel and reworked Cretaceous vertebrate fossils, invertebrate fossils. Clay is calcareous yellowish-gray and forms cuesta of smoothly rounded hills, thickness 300-500 feet.	[illegible]
			Catahoula Formation	Clays and sand, Clay is bentonitic, noncalcareous except for some calcareous concretions locally, light olive gray. Sand is fine to medium grained tuffaceous, cross-bedded lenses, gray, thickness 350± feet.	[illegible]

Note: This map is preliminary in nature and is valid only until publication of the Laredo, Corpus Christi, McAllen, Crystal City and Brownsville sheets of the Geologic Atlas of Texas. Preliminary compilation, Geologic Atlas of Texas, Bureau of Economic Geology, The University of Texas at Austin, Virgil E. Barnes, Project Director.

PLATE 4-3

GEOLOGIC MAP
TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TEMPLE, TEXAS

0 10 20 30 40 MILES
APPROXIMATE SCALE
1:1,000,000 or 1 inch = 15.78 miles

Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection

Sheet 3 of 3 4-R-30,526

USDA SCS FORT WORTH TEX 1971

May 1971 4-R-28553C

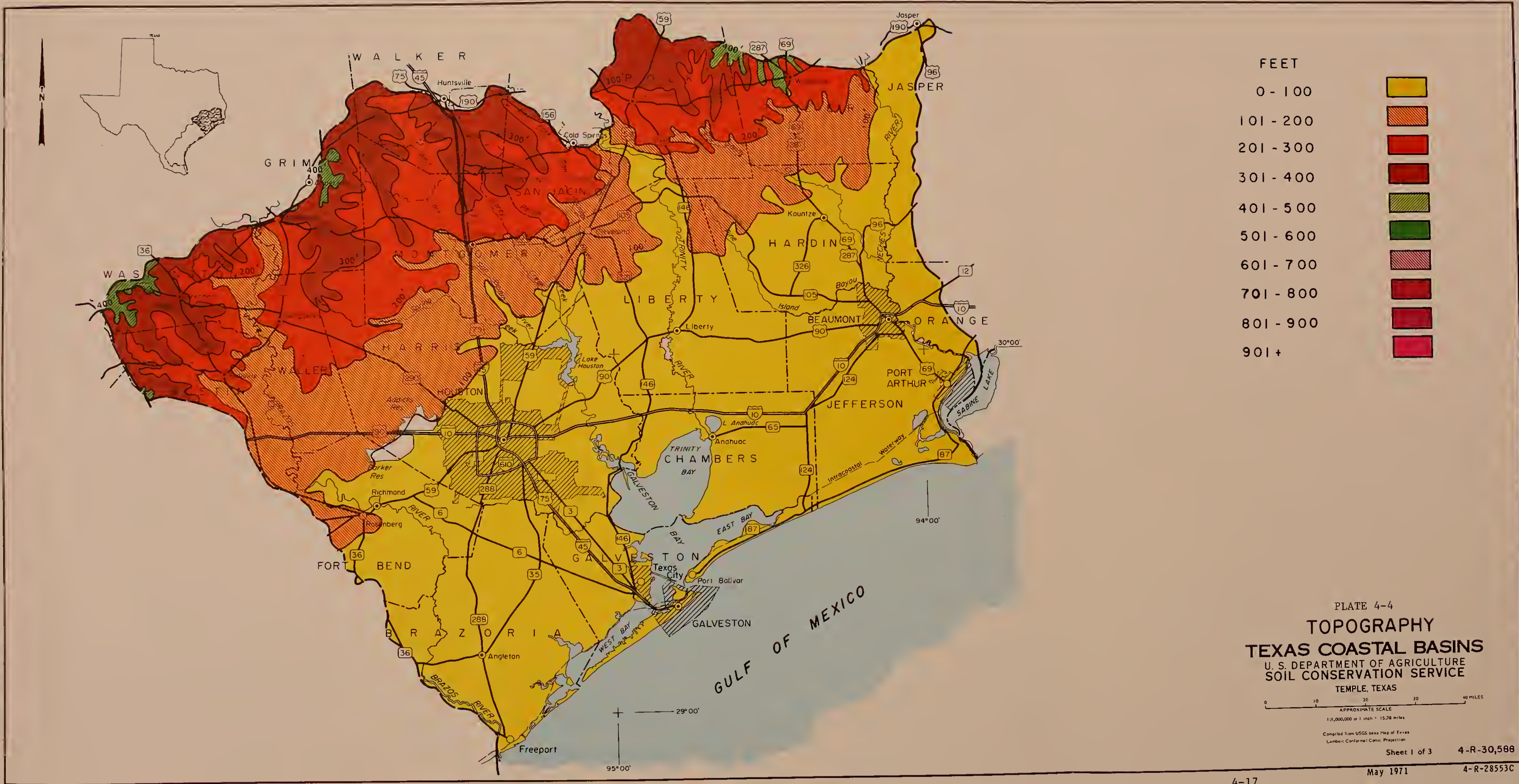


PLATE 4-4

TOPOGRAPHY

TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

May 1971

4-R-28553C

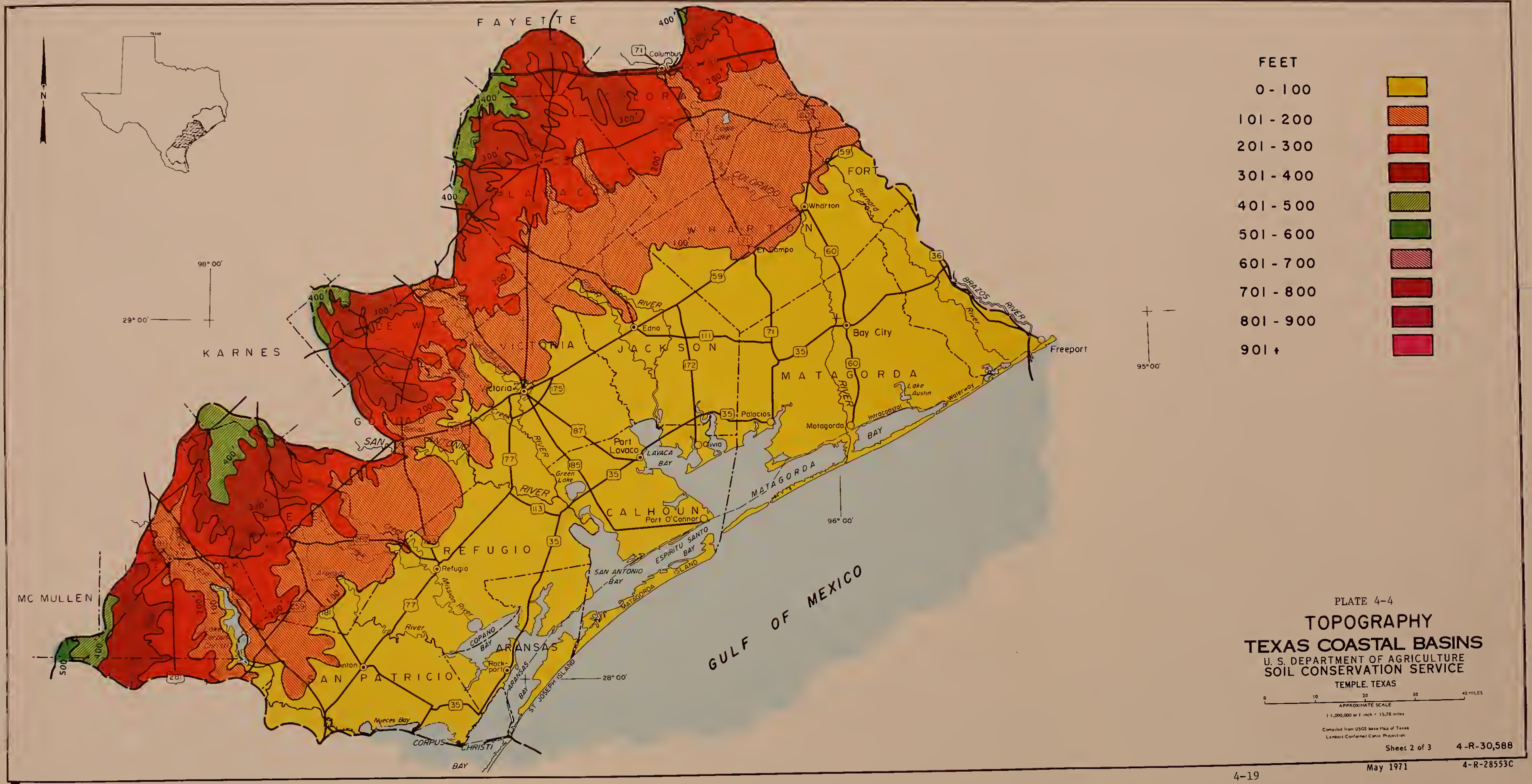
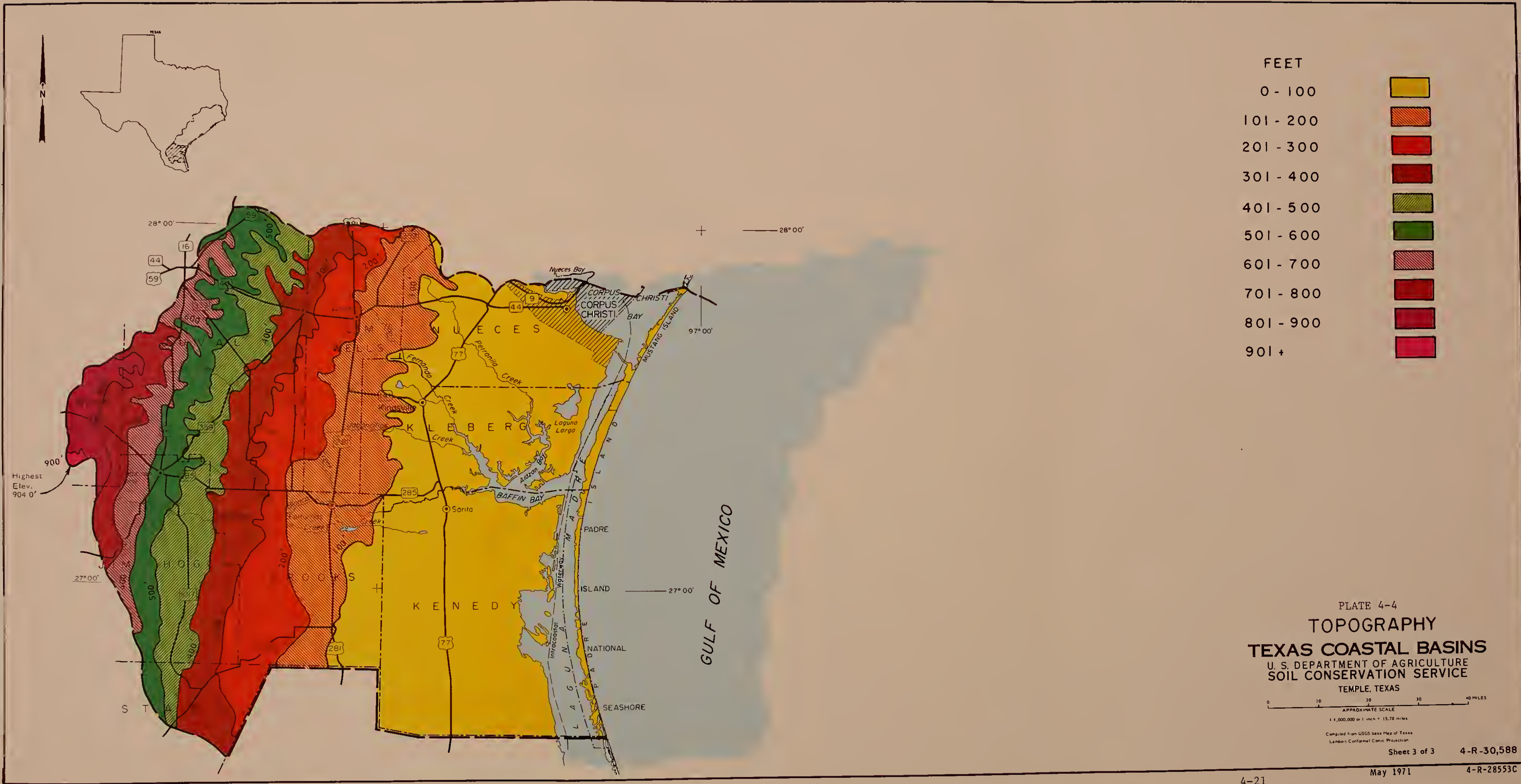


PLATE 4-4
TOPOGRAPHY
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS



May 1971 4-R-28553C

USDA-SCS FORT WORTH, TEX. 1971

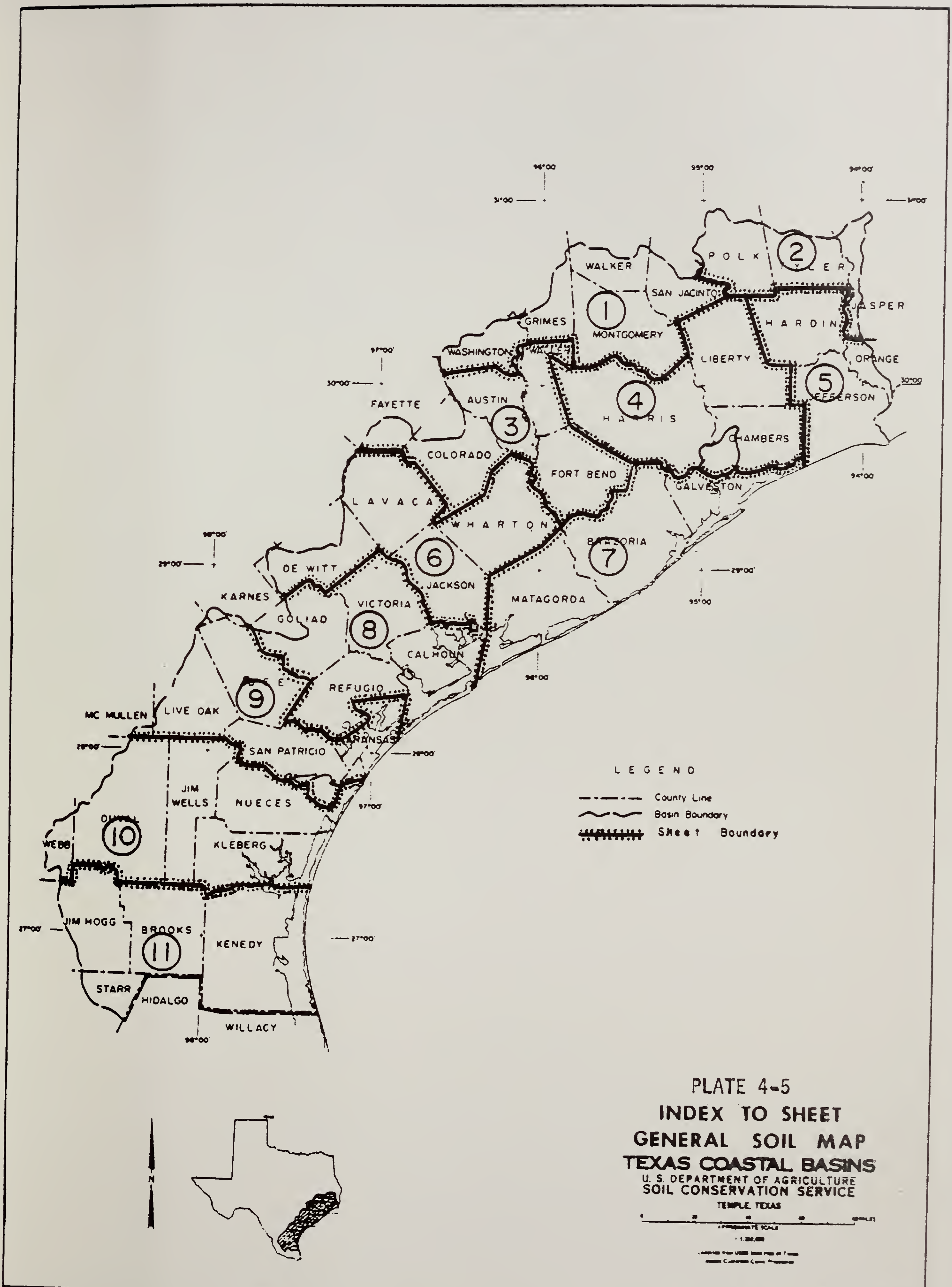


PLATE 4-5
INDEX TO SHEET
GENERAL SOIL MAP
TEXAS COASTAL BASINS

May 1971 4-R-30440

GENERAL SOIL MAP
TEXAS COASTAL BASINS
LEGEND
ADVANCE COPY–SUBJECT TO CHANGE

Below each main heading a terse description and a list of great groups (i.e. Pelluderts) of soils are given for the one or more related soil associations which follow. The associations are the units delineated on the map. They have hyphenated names made up from names of two or three soil series of major extent within the delineation. Soils very similar as to kind, arrangement and thickness of natural layers or horizons are known as a soil series (i.e. Beaumont). A geographic name local to their occurrence is usually used in identifying them. Soil series in each association are in turn keyed to the appropriate great group, a category of scientific soil classification more definitive and at a level lower than the order. Other soil series not named in an association on the Legend occur in the area delineated, but they are inclusions that occupy relatively minor acreage in the association.

Symbols within delineations on the map relate to soil associations described and classified in the legend. Association symbols consist of consecutive numbers followed by a capital letter.

I Cracking clayey soils; soils with loamy surface layers underlain by cracking clayey layers; and soils loamy throughout, some of which are compact beneath the surface layer.

Pelluderts[a*], Argiaquolls[b], Ochraqualfs[c], Pellusterts[d], Calciustolls[e], Chromusterts[f], Argiustolls[g], Paleustalfs[h], Paleudalfs[i], Chromuderts[j].

1-V Lake Charles[a*]-Bernard[b]-Midland[c]
2-V Beaumont[a]-Morey[b]-Lake Charles[a]
3-V Victoria[d]-Orelia[c]-Clareville[g]
4-V Victoria[d]-Raymondville[e]-Orelia[c]
5-V Ferris[f]-Heiden[f]-Crockett[h]
6-V Heiden[f]-Engle[e]-Klump[1/, g]
7-V Heiden[f]-Houston Black[d]-Engle[e]
8-V Garner[a]-Susquehanna[i]-Houston[j]

II Soils with loamy surface layers underlain by cracking, clayey layers; and cracking clayey soils.

Albaqualfs[a], Argiaquolls[b], Pelluderts[c], Paleustalfs[d], Ochraqualfs[e], Chromusterts[f]

9-A Edna[a]-Bernard[b]-Lake Charles[c]
10-A Crockett[d]-Wilson[e]-Heiden[f]

III Soils that are sandy or loamy throughout; or soils with sandy or loamy surface layers underlain by loamy layers.

Paleustalfs[a], Ustipsamments[b], Haplustalfs[c], Paleudalfs[d]

11-A Sarita[a]-Falfurrias[b]-Nueces[a]
12-A Delfina[c]-Nueces[a]
13-A Wockley[1/, d]-Kenney[d]-Hockley[d]

IV Soils with sandy or loamy surface layers underlain by clayey layers most of which are very slowly permeable; and soils with thick sandy surface layers underlain by loamy layers of moderately slow permeability.

Albaqualfs[a], Paleudalfs[b], Ochraqualfs[c], Paleustalfs[d], Paleudults[e], Paleustolls[f]

14-A Edna[a]-Katy[b]-Telferner[a]
15-A Stratton[a]-Tabor[d]-Crockett[d]
16-A Orelia[c]-Leming[d]
17-U Trep[e]-Susquehanna[b]
18-A Fordtran[a]-Telferner[a]-Edna[a]
19-A Orelia[c]-Miguel[d]
20-A Miguel[d]-Leming[d]
21-M Weesatche[1/, f]-Miguel[d]
22-A Demona[d]-Patilo[d]-Axtell[d]

V Deep sandy soils, or soils with sandy surface layers underlain by loamy or clayey layers; saline clayey and loamy soils - all occasionally flooded by storm tides.

Udipsamments[a], Psammaquents[b], Albaqualfs[c], Quartzipsamments[d], Ochraqualfs[e], Fluvaquents[f]

23-E Galveston[a]-Mustang[b]-Rahal[c]
24-E Portalto[d]-Roemer[e]-Veston[f]

VI Soils loamy throughout.

Calciustolls[a], Argiustolls[b], Haplustalfs[c], Ochraqualfs[d], Ustochrepts[e]

25-M Sarnosa[a]-Runge[b]
26-M Willacy[b]-Delfina[c]-Orelia[d]
27-I McAllen[e]-Brennan[c]

VII Soils loamy throughout or with loamy surface layers underlain by clayey layers. Most of the soils have strongly cemented caliche beginning at about 10 to 40 inch depths.

Paleustalfs[a], Paleargids[b], Calciustolls[c], Paleustolls[d], Argiustolls[e]

28-A Delmita[a]-Randado[b]
29-M Olmos[c]-Goliad[d]-Runge[e]
30-M Pernitas[1/, c]-Olmos[c]-Goliad[d]

VIII Soils loamy throughout or with loamy surface layers underlain by clayey layers; some clayey throughout. All are somewhat poorly to poorly drained.

Argiaquolls[a], Albaqualfs[b], Glossaqualfs[c], Ochraqualfs[d], Chromuderts[e]

31-M Morey[a]-Anahuac[b]-Frost[c]
32-M Bernard[a]-Morey[a]-Clodine[d]
33-V Vaiden[e]-Acadia[d]-Crowley[b]

IX Saline soils clayey or loamy throughout.

Haplaquolls[a], Fluvaquents[b], Argiaquolls[c], Ochraqualfs[d]

34-M Harris[a]-Ijam[b]
35-M Harris[a]-Morey[c]-Clodine[d]

X Soils clayey throughout; or soils with loamy surface layers underlain by clayey layers. All are saline soils.

Natraqualfs[a], Hapludolls[b]

36-A Livia[a]-Francitas[a]-Matagorda[a]
37-M Pledger[b]-Moreland[b]

XI Soils sandy throughout or with sandy surface layers underlain by loamy layers; or soils with loamy surface layers underlain by clayey layers.

Paleudults[a], Hapludults[b], Paleudalfs[c], Glossaqualfs[d]

38-U Conroe[a]-Darco[a]-Fuquay[a]
39-U Fuquay[a]-Troup[a]-Saciul[b]
40-A Bienville[c]-Wrightsville[d]
41-A Susquehanna[c]-Segno[c]

XII Soils loamy throughout or with loamy surface layers underlain by clayey layers; and soils with sandy surface layers underlain by loamy layers.

Paleudalfs[a], Fragiudalfs[b], Glossaqualfs[c]

42-A Segno[a]-Splendora[b]-Waller[c]
43-A Segno[a]-Hockley[a]-Bernaldo[a]
44-A Erno[b]-Woden[a]-Wrightsville[c]

XIII Soils loamy throughout or soils with loamy surface layers underlain by clayey layers. All soils somewhat poorly or poorly drained

Paleudalfs[a], Glossaqualfs[b], Argiaquolls[c], Ochraqualfs[d], Albaqualfs[e], Fragiudalfs[f]

45-A Sorter[d]-Splendora[f]-Waller[b]
46-A Wockley[1/, a]-Katy[a]-Gessner[1/, b]
47-M Addicks[1/, c]-Clodine[d]-Gessner[1/, b]
48-A Falba[1/, e]-Arol[1/, e]-Elmina[1/, e]

XIV Soils with gravelly, loamy surface layers underlain by clayey layers

Paleustalfs[a]

49-A Witt[1/, a]-Tabor[a]

XV Noncalcareous and calcareous, cracking clayey soils and calcareous loamy soils; and strongly acid clayey and loamy soils. All bottom land soils.

Hapludolls[a], Haplustolls[b], Udifluvents[c], Haplaquolls[d], Haplaquepts[e], Fluvaquents[f]

50-M Moreland[a]-Pledger[a]-Norwood[c]
51-M Miller[b]-Norwood[c]-Pledger[a]
52-M Kaufman[d]-Tuscumbia[e], Nahatche[f]
53-M Trinity[d]-Frio[b]
54-I Urbo[e]-Mantachie[f]
55-M Aransas[d]-Sinton[b]-Odem[b]

*The classification at the Great Group level of soils series in each soil association is indicated by the matching small letters.

1/ Field name, subject to change.

5-72 4-R-30896 LEGEND


WALKER
GRIM
WAS
48-A
17-U
43-A
5-V
8-V
52-M
43-A
22-A
38-U
5-V
22-A
51-M
41-A
17-U
22-A
5-V
52-M
42-A
42-A
15-A
45-A
43-A
6-V
6-V
38-U
43-A
42-A
45-A
5-V
22-A
5-V
42-A
51-M
N
PLATE 4-5
GENERAL SOIL MAP
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS
0
10
20 MILES
APPROXIMATE SCALE
1:500,000 or 1 inch = 7.891 MILES
Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection
Sheet 1 of 11
4-R-30896

GENERAL SOIL MAP

TEXAS COASTAL BASINS

LEGEND

ADVANCE COPY—SUBJECT TO CHANGE

Below each main heading a terse description and a list of great groups (i.e. Pelluderts) of soils are given for the one or more related soil associations which follow. The associations are the units delineated on the map. They have hyphenated names made up from names of two or three soil series of major extent within the delineation. Soils very similar as to kind, arrangement and thickness of natural layers or horizons are known as a soil series (i.e. Beaumont). A geographic name local to their occurrence is usually used in identifying them. Soil series in each association are in turn keyed to the appropriate great group, a category of scientific soil classification more definitive and at a level lower than the order. Other soil series not named in an association on the Legend occur in the area delineated, but they are inclusions that occupy relatively minor acreage in the association.

Symbols within delineations on the map relate to soil associations described and classified in the legend. Association symbols consist of consecutive numbers followed by a capital letter.

I

Cracking clayey soils; soils with loamy surface layers underlain by cracking clayey layers; and soils loamy throughout, some of which are compact beneath the surface layer.

Pelluderts[a*], Argiaquolls[b], Ochraqualfs[c], Pellusterts[d], Calciustolls[e], Chromusterts[f], Argiustolls[g], Paleustalfs[h], Paleudalfs[i], Chromuderts[j].

1-V Lake Charles[a*]-Bernard[b]-Midland[c]
2-V Beaumont[a]-Morey[b]-Lake Charles[a]
3-V Victoria[d]-Orelia[c]-Clareville[g]
4-V Victoria[d]-Raymondville[e]-Orelia[c]
5-V Ferris[f]-Heiden[f]-Crockett[h]
6-V Heiden[f]-Engle[e]-Klump[1/g]
7-V Heiden[f]-Houston Black[d]-Engle[e]
8-V Garner[a]-Susquehanna[i]-Houston[j]

II

Soils with loamy surface layers underlain by cracking, clayey layers; and cracking clayey soils.

Albaqualfs[a], Argiaquolls[b], Pelluderts[c], Paleustalfs[d], Ochraqualfs[e], Chromusterts[f]

9-A Edna[a]-Bernard[b]-Lake Charles[c]
10-A Crockett[d]-Wilson[e]-Heiden[f]

III

Soils that are sandy or loamy throughout; or soils with sandy or loamy surface layers underlain by loamy layers.

Paleustalfs[a], Ustipsamments[b], Haplustalfs[c], Paleudalfs[d]

11-A Sarita[a]-Falfurrias[b]-Nueces[a]
12-A Oelfina[c]-Nueces[a]
13-A Wockley[1/d]-Kenney[d]-Hockley[d]

IV

Soils with sandy or loamy surface layers underlain by clayey layers most of which are very slowly permeable; and soils with thick sandy surface layers underlain by loamy layers of moderately slow permeability.

Albaqualfs[a], Paleudalfs[b], Ochraqualfs[c], Paleustalfs[d], Paleudults[e], Paleustolls[f]

14-A Edna[a]-Katy[b]-Telferner[a]
15-A Stratton[a]-Tabor[d]-Crockett[d]
16-A Orelia[c]-Leming[d]
17-U Trep[e]-Susquehanna[b]
18-A Fordtran[a]-Telferner[a]-Edna[a]
19-A Orelia[c]-Miguel[d]
20-A Miguel[d]-Leming[d]
21-M Weesatche[1/f]-Miguel[d]
22-A Oemona[d]-Patilo[d]-Axtell[d]

V

Deep sandy soils, or soils with sandy surface layers underlain by loamy or clayey layers; saline clayey and loamy soils - all occasionally flooded by storm tides.

Udipsamments[a], Psammaquents[b], Albaqualfs[c], Quartzipsamments[d], Ochraqualfs[e], Fluvaquents[f]

23-E Galveston[a]-Mustang[b]-Rahal[c]
24-E Portalto[d]-Roemer[e]-Veston[f]

VI

Soils loamy throughout.

Calciustolls[a], Argiustolls[b], Haplustalfs[c], Ochraqualfs[d], Ustochrepts[e]

25-M Sarnosa[a]-Runge[b]
26-M Willacy[b]-Oelfina[c]-Orelia[d]
27-I McAllen[e]-Brennan[c]

Soils loamy throughout or with loamy surface layers underlain by clayey layers. Most of the soils have strongly cemented caliche beginning at about 10 to 40 inch depths.

Paleustalfs[a], Paleargids[b], Calciustolls[c], Paleustolls[d], Argiustolls[e]

28-A Delmita[a]-Randado[b]
29-M Olmos[c]-Goliad[d]-Runge[e]
30-M Pernitas[1/c]-Olmos[c]-Goliad[d]

VIII

Soils loamy throughout or with loamy surface layers underlain by clayey layers; some clayey throughout. All are somewhat poorly to poorly drained.

Argiaquolls[a], Albaqualfs[b], Glossaqualfs[c], Ochraqualfs[d], Chromuderts[e]

31-M Morey[a]-Anahuac[b]-Frost[c]
32-M Bernard[a]-Morey[a]-Clodine[d]
33-V Vaiden[e]-Acadia[d]-Crowley[b]

IX

Saline soils clayey or loamy throughout.

Haplaquolls[a], Fluvaquents[b], Argiaquolls[c], Ochraqualfs[d]

34-M Harris[a]-Ijam[b]
35-M Harris[a]-Morey[c]-Clodine[d]

X

Soils clayey throughout; or soils with loamy surface layers underlain by clayey layers. All are saline soils.

Natraqualfs[a], Hapludolls[b]

36-A Livia[a]-Francitas[a]-Matagorda[a]
37-M Pledger[b]-Moreland[b]

Soils sandy throughout or with sandy surface layers underlain by loamy layers; or soils with loamy surface layers underlain by clayey layers.

Paleudults[a], Hapludults[b], Paleudalfs[c], Glossaqualfs[d]

38-U Conroe[a]-Oarco[a]-Fuquay[a]
39-U Fuquay[a]-Troup[a]-Sacul[b]
40-A Bienville[c]-Wrightsville[d]
41-A Susquehanna[c]-Segno[c]

XII

Soils loamy throughout or with loamy surface layers underlain by clayey layers; and soils with sandy surface layers underlain by loamy layers.

Paleudalfs[a], Fragiudalfs[b], Glossaqualfs[c]

42-A Segno[a]-Splendora[b]-Waller[c]
43-A Segno[a]-Hockley[a]-Bernaldo[a]
44-A Erno[b]-Woden[a]-Wrightsville[c]

Soils loamy throughout or soils with loamy surface layers underlain by clayey layers. All soils somewhat poorly or poorly drained

Paleudalfs[a], Glossaqualfs[b], Argiaquolls[c], Ochraqualfs[d], Albaqualfs[e], Fragiudalfs[f]

45-A Sorter[d]-Splendora[f]-Waller[b]
46-A Wockley[1/a]-Katy[a]-Gessner[1/b]
47-M Addicks[1/c]-Clodine[d]-Gessner[1/b]
48-A Falba[1/e]-Arol[1/e]-Elmina[1/e]

XIV

Soils with gravelly, loamy surface layers underlain by clayey layers

Paleustalfs[a]

49-A Witt[1/a]-Tabor[a]

XV

Noncalcareous and calcareous, cracking clayey soils and calcareous loamy soils; and strongly acid clayey and loamy soils. All bottom land soils.

Hapludolls[a], Haplustolls[b], Udifluvents[c], Haplaquolls[d], Haplaquepts[e], Fluvaquents[f]

50-M Moreland[a]-Pledger[a]-Norwood[c]
51-M Miller[b]-Norwood[c]-Pledger[a]
52-M Kaufman[d]-Tuscumbia[e], Nahatche[f]
53-M Trinity[d]-Frio[b]
54-I Urbo[e]-Mantachie[f]
55-M Aransas[d]-Sinton[b]-Odem[b]

*The classification at the Great Group level of soils series in each soil association is indicated by the matching small letters.

1/ Field name, subject to change.

5-72 4-R-30896 LEGEND

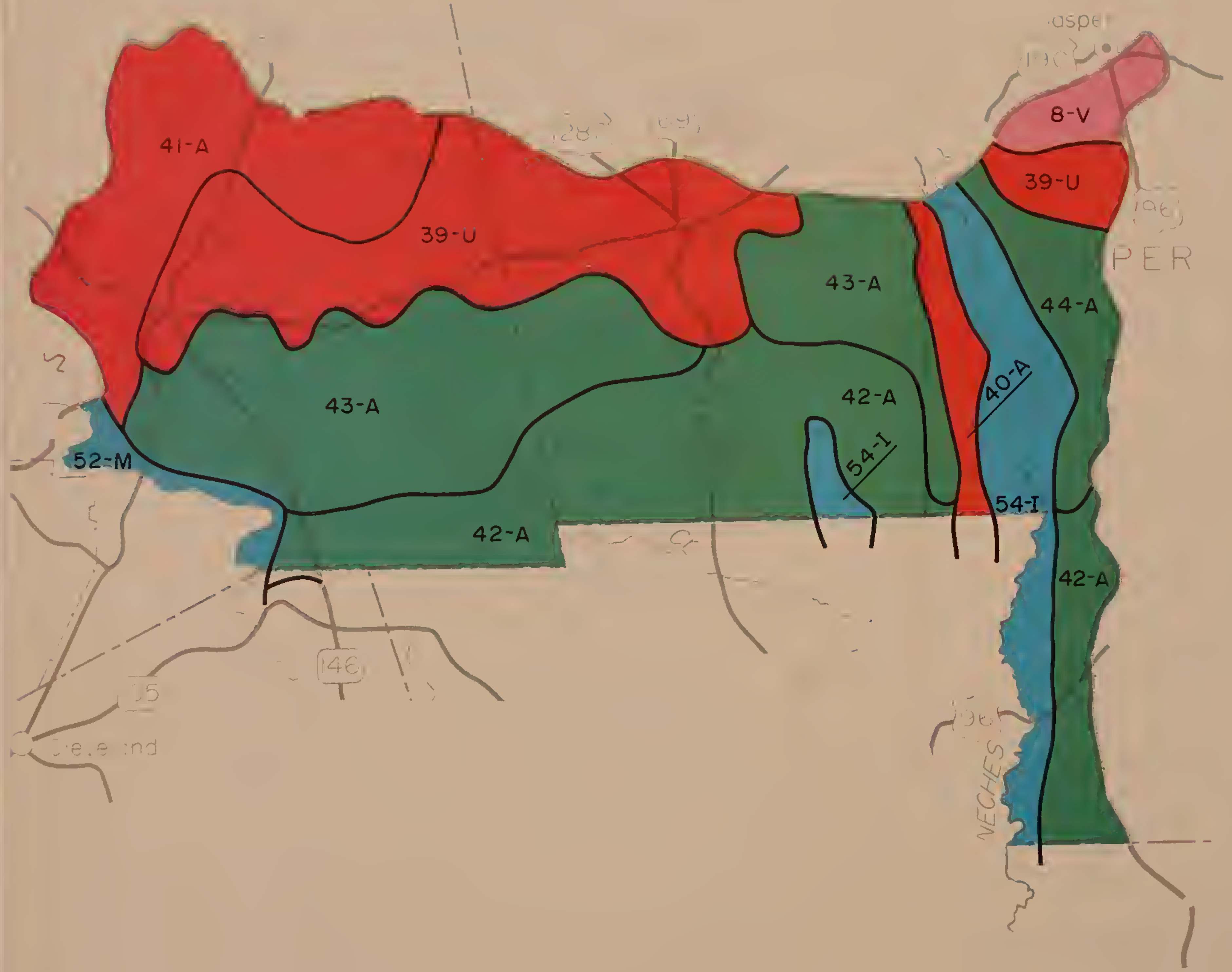


PLATE 4-5

GENERAL SOIL MAP

TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

0 10 20 MILES
APPROXIMATE SCALE
1 500,000 or 1 inch = 7.89 MILES

Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection

Sheet 2 of 11

4–R–30896

May 1971

4–R–28553D

GENERAL SOIL MAP
TEXAS COASTAL BASINS
LEGEND
ADVANCE COPY—SUBJECT TO CHANGE

Below each main heading a terse description and a list of great groups (i.e. Pelluderts) of soils are given for the one or more related soil associations which follow. The associations are the units delineated on the map. They have hyphenated names made up from names of two or three soil series of major extent within the delineation. Soils very similar as to kind, arrangement and thickness of natural layers or horizons are known as a soil series (i.e. Beaumont). A geographic name local to their occurrence is usually used in identifying them. Soil series in each association are in turn keyed to the appropriate great group, a category of scientific soil classification more definitive and at a level lower than the order. Other soil series not named in an association on the Legend occur in the area delineated, but they are inclusions that occupy relatively minor acreage in the association.

Symbols within delineations on the map relate to soil associations described and classified in the legend. Association symbols consist of consecutive numbers followed by a capital letter.

I

Cracking clayey soils; soils with loamy surface layers underlain by cracking clayey layers; and soils loamy throughout, some of which are compact beneath the surface layer.

Pelluderts[a*], Argiaquolls[b], Ochraqualfs[c], Pellusterts[d], Calciustolls[e], Chromusterts[f], Argiustolls[g], Paleustalfs[h], Paleudalfs[i], Chromuderts[j].

1-V Lake Charles[a*]-Bernard[b]-Midland[c]
2-V Beaumont[a]-Morey[b]-Lake Charles[a]
3-V Victoria[d]-Orelia[c]-Clareville[g]
4-V Victoria[d]-Raymondville[e]-Orelia[c]
5-V Ferris[f]-Heiden[f]-Crockett[h]
6-V Heiden[f]-Engle[e]-Klump[1/g]
7-V Heiden[f]-Houston Black[d]-Engle[e]
8-V Garner[a]-Susquehanna[i]-Houston[j]

II

Soils with loamy surface layers underlain by cracking, clayey layers; and cracking clayey soils.

Albaqualfs[a], Argiaquolls[b], Pelluderts[c], Paleustalfs[d], Ochraqualfs[e], Chromusterts[f]

9-A Edna[a]-Bernard[b]-Lake Charles[c]
10-A Crockett[d]-Wilson[e]-Heiden[f]

III

Soils that are sandy or loamy throughout; or soils with sandy or loamy surface layers underlain by loamy layers.

Paleustalfs[a], Ustipsamments[b], Haplustalfs[c], Paleudalfs[d]

11-A Sarita[a]-Falfurrias[b]-Nueces[a]
12-A Delfina[c]-Nueces[a]
13-A Wockley[1/d]-Kenney[d]-Hockley[d]

IV

Soils with sandy or loamy surface layers underlain by clayey layers most of which are very slowly permeable; and soils with thick sandy surface layers underlain by loamy layers of moderately slow permeability.

Albaqualfs[a], Paleudalfs[b], Ochraqualfs[c], Paleustalfs[d], Paleudults[e], Paleustolls[f]

14-A Edna[a]-Katy[b]-Telferner[a]
15-A Stratton[a]-Tabor[d]-Crockett[d]
16-A Orelia[c]-Leming[d]
17-U Trep[e]-Susquehanna[b]
18-A Fordtran[a]-Telferner[a]-Edna[a]
19-A Orelia[c]-Miguel[d]
20-A Miguel[d]-Leming[d]
21-M Weesatche[1/f]-Miguel[d]
22-A Demona[d]-Patilo[d]-Axtell[d]

V

Deep sandy soils, or soils with sandy surface layers underlain by loamy or clayey layers; saline clayey and loamy soils - all occasionally flooded by storm tides.

Udipsamments[a], Psammaquents[b], Albaqualfs[c], Quartzipsamments[d], Ochraqualfs[e], Fluvaquents[f]

23-E Galveston[a]-Mustang[b]-Rahal[c]
24-E Portalto[d]-Roemer[e]-Veston[f]

VI

Soils loamy throughout.

Calciustolls[a], Argiustolls[b], Haplustalfs[c], Ochraqualfs[d], Ustochrepts[e]

25-M Sarnosa[a]-Runge[b]
26-M Willacy[b]-Delfina[c]-Orelia[d]
27-I McAllen[e]-Brennan[c]

VII

Soils loamy throughout or with loamy surface layers underlain by clayey layers. Most of the soils have strongly cemented caliche beginning at about 10 to 40 inch depths.

Paleustalfs[a], Paleargids[b], Calciustolls[c], Paleustolls[d], Argiustolls[e]

28-A Delmita[a]-Randado[b]
29-M Olmos[c]-Goliad[d]-Runge[e]
30-M Pernitas[1/c]-Olmos[c]-Goliad[d]

VIII

Soils loamy throughout or with loamy surface layers underlain by clayey layers; some clayey throughout. All are somewhat poorly to poorly drained.

Argiaquolls[a], Albaqualfs[b], Glossaqualfs[c], Ochraqualfs[d], Chromuderts[e]

31-M Morey[a]-Anahuac[b]-Frost[c]
32-M Bernard[a]-Morey[a]-Clodine[d]
33-V Vaiden[e]-Acadia[d]-Crowley[b]

IX

Saline soils clayey or loamy throughout.

Haplaquolls[a], Fluvaquents[b], Argiaquolls[c], Ochraqualfs[d]

34-M Harris[a]-Ijam[b]
35-M Harris[a]-Morey[c]-Clodine[d]

X

Soils clayey throughout; or soils with loamy surface layers underlain by clayey layers. All are saline soils.

Natraqualfs[a], Hapludolls[b]

36-A Livia[a]-Francitas[a]-Matagorda[a]
37-M Pledger[b]-Moreland[b]

XI

Soils sandy throughout or with sandy surface layers underlain by loamy layers; or soils with loamy surface layers underlain by clayey layers.

Paleudults[a], Hapludults[b], Paleudalfs[c], Glossaqualfs[d]

38-U Conroe[a]-Oarco[a]-Fuquay[a]
39-U Fuquay[a]-Troup[a]-Sacul[b]
40-A Bienville[c]-Wrightsville[d]
41-A Susquehanna[c]-Segno[c]

XII

Soils loamy throughout or with loamy surface layers underlain by clayey layers; and soils with sandy surface layers underlain by loamy layers.

Paleudalfs[a], Fragiudalfs[b], Glossaqualfs[c]

42-A Segno[a]-Splendora[b]-Waller[c]
43-A Segno[a]-Hockley[a]-Bernaldo[a]
44-A Erno[b]-Woden[a]-Wrightsville[c]

XIII

Soils loamy throughout or soils with loamy surface layers underlain by clayey layers. All soils somewhat poorly or poorly drained

Paleudalfs[a], Glossaqualfs[b], Argiaquolls[c], Ochraqualfs[d], Albaqualfs[e], Fragiudalfs[f]

45-A Sorter[d]-Splendora[f]-Waller[b]
46-A Wockley[1/a]-Katy[a]-Gessner[1/b]
47-M Addicks[1/c]-Clodine[d]-Gessner[1/b]
48-A Falba[1/e]-Aroll[1/e]-Elmina[1/e]

XIV

Soils with gravelly, loamy surface layers underlain by clayey layers

Paleustalfs[a]

49-A Witt[1/a]-Tabor[a]

XV

Noncalcareous and calcareous, cracking clayey soils and calcareous loamy soils; and strongly acid clayey and loamy soils. All bottom land soils.

Hapludolls[a], Haplustolls[b], Udifluvents[c], Haplaquolls[d], Haplaquepts[e], Fluvaquents[f]

50-M Moreland[a]-Pledger[a]-Norwood[c]
51-M Miller[b]-Norwood[c]-Pledger[a]
52-M Kaufman[d]-Tuscumbia[e], Nahatche[f]
53-M Trinity[d]-Frio[b]
54-I Urbo[e]-Mantachie[f]
55-M Aransas[d]-Sinton[b]-Odem[b]

*The classification at the Great Group level of soils series in each soil association is indicated by the matching small letters.

1/ Field name, subject to change.

5-72 4-R-30896 LEGEND

USDA SCS FT. WORTH TEXAS 1972

PLATE 4-5
GENERAL SOIL MAP
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

4-R-28553D

May 1971

GENERAL SOIL MAP
TEXAS COASTAL BASINS
LEGEND

ADVANCE COPY—SUBJECT TO CHANGE

Below each main heading a terse description and a list of great groups (i.e. Pelluderts) of soils are given for the one or more related soil associations which follow. The associations are the units delineated on the map. They have hyphenated names made up from names of two or three soil series of major extent within the delineation. Soils very similar as to kind, arrangement and thickness of natural layers or horizons are known as a soil series (i.e. Beaumont). A geographic name local to their occurrence is usually used in identifying them. Soil series in each association are in turn keyed to the appropriate great group, a category of scientific soil classification more definitive and at a level lower than the order. Other soil series not named in an association on the Legend occur in the area delineated, but they are inclusions that occupy relatively minor acreage in the association.

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I Cracking clayey soils; soils with loamy surface layers underlain by cracking clayey layers; and soils loamy throughout, some of which are compact beneath the surface layer.

Pelluderts[a*], Argiaquolls[b], Ochraqualfs[c], Pellusterts[d], Calciustolls[e], Chromusterts[f], Argiustolls[g], Paleustalfs[h], Paleudalfs[i], Chromuderts[j].

1-V Lake Charles[a*]-Bernard[b]-Midland[c]
2-V Beaumont[a]-Morey[b]-Lake Charles[a]
3-V Victoria[d]-Orelia[c]-Clareville[g]
4-V Victoria[d]-Raymondville[e]-Orelia[c]
5-V Ferris[f]-Heiden[f]-Crockett[h]
6-V Heiden[f]-Engle[e]-Klump[1/g]
7-V Heiden[f]-Houston Black[d]-Engle[e]
8-V Garner[a]-Susquehanna[i]-Houston[j]

II Soils with loamy surface layers underlain by cracking, clayey layers; and cracking clayey soils.

Albaqualfs[a], Argiaquolls[b], Pelluderts[c], Paleustalfs[d], Ochraqualfs[e], Chromusterts[f]

9-A Edna[a]-Bernard[b]-Lake Charles[c]
10-A Crockett[d]-Wilson[e]-Heiden[f]

III Soils that are sandy or loamy throughout; or soils with sandy or loamy surface layers underlain by loamy layers.

Paleustalfs[a], Ustipsamments[b], Haplustalfs[c], Paleudalfs[d]

11-A Sarita[a]-Falfurrias[b]-Nueces[a]
12-A Oelfina[c]-Nueces[a]
13-A Wockley[1/d]-Kenney[d]-Hockley[d]

IV Soils with sandy or loamy surface layers underlain by clayey layers most of which are very slowly permeable; and soils with thick sandy surface layers underlain by loamy layers of moderately slow permeability.

Albaqualfs[a], Paleudalfs[b], Ochraqualfs[c], Paleustalfs[d], Paleudults[e], Paleustolls[f]

14-A Edna[a]-Katy[b]-Telferner[a]
15-A Stratton[a]-Tabor[d]-Crockett[d]
16-A Orelia[c]-Leming[d]
17-U Trep[e]-Susquehanna[b]
18-A Fordtran[a]-Telferner[a]-Edna[a]
19-A Orelia[c]-Miguel[d]
20-A Miguel[d]-Leming[d]
21-M Weesatche[1/f]-Miguel[d]
22-A Oemona[d]-Patilo[d]-Axtell[d]

V Deep sandy soils, or soils with sandy surface layers underlain by loamy or clayey layers; saline clayey and loamy soils - all occasionally flooded by storm tides.

Udipsamments[a], Psammaquents[b], Albaqualfs[c], Quartzipsamments[d], Ochraqualfs[e], Fluvaquents[f]

23-E Galveston[a]-Mustang[b]-Rahal[c]
24-E Portalto[d]-Roemer[e]-Veston[f]

VI Soils loamy throughout.

Calciustolls[a], Argiustolls[b], Haplustalfs[c], Ochraqualfs[d], Ustochrepts[e]

25-M Sarnosa[a]-Runge[b]
26-M Willacy[b]-Oelfina[c]-Orelia[d]
27-I McAllen[e]-Brennan[c]

VII Soils loamy throughout or with loamy surface layers underlain by clayey layers. Most of the soils have strongly cemented caliche beginning at about 10 to 40 inch depths.

Paleustalfs[a], Paleargids[b], Calciustolls[c], Paleustolls[d], Argiustolls[e]

28-A Oelmita[a]-Randado[b]
29-M Olmos[c]-Goliad[d]-Runge[e]
30-M Pernitas[1/c]-Olmos[c]-Goliad[d]

VIII Soils loamy throughout or with loamy surface layers underlain by clayey layers; some clayey throughout. All are somewhat poorly to poorly drained.

Argiaquolls[a], Albaqualfs[b], Glossaqualfs[c], Ochraqualfs[d], Chromuderts[e]

31-M Morey[a]-Anahuac[b]-Frost[c]
32-M Bernard[a]-Morey[a]-Clodine[d]
33-V Valden[e]-Acadia[d]-Crowley[b]

IX Saline soils clayey or loamy throughout.

Haplaquolls[a], Fluvaquents[b], Argiaquolls[c], Ochraqualfs[d]

34-M Harris[a]-Ijam[b]
35-M Harris[a]-Morey[c]-Clodine[d]

X Soils clayey throughout; or soils with loamy surface layers underlain by clayey layers. All are saline soils.

Natraqualfs[a], Hapludolls[b]

36-A Livia[a]-Francitas[a]-Matagorda[a]
37-M Pledger[b]-Moreland[b]

XI Soils sandy throughout or with sandy surface layers underlain by loamy layers; or soils with loamy surface layers underlain by clayey layers.

Paleudults[a], Hapludults[b], Paleudalfs[c], Glossaqualfs[d]

38-U Conroe[a]-Oarco[a]-Fuquay[a]
39-U Fuquay[a]-Troup[a]-Sacul[b]
40-A Bienville[c]-Wrightsville[d]
41-A Susquehanna[c]-Segno[c]

XII Soils loamy throughout or with loamy surface layers underlain by clayey layers; and soils with sandy surface layers underlain by loamy layers.

Paleudalfs[a], Fragiudalfs[b], Glossaqualfs[c]

42-A Segno[a]-Splendora[b]-Waller[c]
43-A Segno[a]-Hockley[a]-Bernaldo[a]
44-A Erno[b]-Woden[a]-Wrightsville[c]

XIII Soils loamy throughout or soils with loamy surface layers underlain by clayey layers. All soils somewhat poorly or poorly drained

Paleudalfs[a], Glossaqualfs[b], Argiaquolls[c], Ochraqualfs[d], Albaqualfs[e], Fragiudalfs[f]

45-A Sorter[d]-Splendora[f]-Waller[b]
46-A Wockley[1/a]-Katy[a]-Gessner[1/b]
47-M Addicks[1/c]-Clodine[d]-Gessner[1/b]
48-A Falba[1/e]-Aroli[1/e]-Elmina[1/e]

XIV Soils with gravelly, loamy surface layers underlain by clayey layers

Paleustalfs[a]

49-A Witt[1/a]-Tabor[a]

XV Noncalcareous and calcareous, cracking clayey soils and calcareous loamy soils; and strongly acid clayey and loamy soils. All bottom land soils.

Hapludolls[a], Haplustolls[b], Udifluvents[c], Haplaquolls[d], Haplaquepts[e], Fluvaquents[f]

50-M Moreland[a]-Pledger[a]-Norwood[c]
51-M Miller[b]-Norwood[c]-Pledger[a]
52-M Kaufman[d]-Tuscumbia[e], Nahatche[f]
53-M Trinity[d]-Frio[b]
54-I Urbo[e]-Mantachie[f]
55-M Aransas[d]-Sinton[b]-Odem[b]

*The classification at the Great Group level of soils series in each soil association is indicated by the matching small letters.

1/ Field name, subject to change.

5–72 4–R–30896 LEGEND

USDA SCS FT WORTH TEXAS 1972

PLATE 4-5

GENERAL SOIL MAP

TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TEMPLE, TEXAS

0 10 20 MILES
APPROXIMATE SCALE
1:500,000 or 1 inch = 7.891 MILES

Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection

Sheet 4 of 11

4–R–30896

May 1971

4–R–28553D

GENERAL SOIL MAP

TEXAS COASTAL BASINS

LEGEND

ADVANCE COPY—SUBJECT TO CHANGE

Below each main heading a terse description and a list of great groups (i.e. Pelluderts) of soils are given for the one or more related soil associations which follow. The associations are the units delineated on the map. They have hyphenated names made up from names of two or three soil series of major extent within the delineation. Soils very similar as to kind, arrangement and thickness of natural layers or horizons are known as a soil series (i.e. Beaumont). A geographic name local to their occurrence is usually used in identifying them. Soil series in each association are in turn keyed to the appropriate great group, a category of scientific soil classification more definitive and at a level lower than the order. Other soil series not named in an association on the Legend occur in the area delineated, but they are inclusions that occupy relatively minor acreage in the association.

Symbols within delineations on the map relate to soil associations described and classified in the legend. Association symbols consist of consecutive numbers followed by a capital letter.

I Cracking clayey soils; soils with loamy surface layers underlain by cracking clayey layers; and soils loamy throughout, some of which are compact beneath the surface layer.

Pelluderts[a*], Argiaquolls[b], Ochraqualfs[c], Pellusterts[d], Calciustolls[e], Chromusterts[f], Argiustolls[g], Paleustalfs[h], Paleudalfs[i], Chromuderts[j].

1-V Lake Charles[a*]-Bernard[b]-Midland[c]
2-V Beaumont[a]-Morey[b]-Lake Charles[a]
3-V Victoria[d]-Orelia[c]-Clareville[g]
4-V Victoria[d]-Raymondville[e]-Orelia[c]
5-V Ferris[f]-Heiden[f]-Crockett[h]
6-V Heiden[f]-Engle[e]-Klump[1/g]
7-V Heiden[f]-Houston Black[d]-Engle[e]
8-V Garner[a]-Susquehanna[i]-Houston[j]

II Soils with loamy surface layers underlain by cracking, clayey layers; and cracking clayey soils.

Albaqualfs[a], Argiaquolls[b], Pelluderts[c], Paleustalfs[d], Ochraqualfs[e], Chromusterts[f]

9-A Edna[a]-Bernard[b]-Lake Charles[c]
10-A Crockett[d]-Wilson[e]-Heiden[f]

III Soils that are sandy or loamy throughout; or soils with sandy or loamy surface layers underlain by loamy layers.

Paleustalfs[a], Ustipsamments[b], Haplustalfs[c], Paleudalfs[d]

11-A Sarita[a]-Falfurrias[b]-Nueces[a]
12-A Delfina[c]-Nueces[a]
13-A Wockley[1/d]-Kenney[d]-Hockley[d]

IV Soils with sandy or loamy surface layers underlain by clayey layers most of which are very slowly permeable; and soils with thick sandy surface layers underlain by loamy layers of moderately slow permeability.

Albaqualfs[a], Paleudalfs[b], Ochraqualfs[c], Paleustalfs[d], Paleudults[e], Paleustolls[f]

14-A Edna[a]-Katy[b]-Telferner[a]
15-A Stratton[a]-Tabor[d]-Crockett[d]
16-A Orelia[c]-Leming[d]
17-U Trep[e]-Susquehanna[b]
18-A Fordtran[a]-Telferner[a]-Edna[a]
19-A Orelia[c]-Miguel[d]
20-A Miguel[d]-Leming[d]
21-M Weesatche[1/f]-Miguel[d]
22-A Demona[d]-Patilo[d]-Axtell[d]

V Deep sandy soils, or soils with sandy surface layers underlain by loamy or clayey layers; saline clayey and loamy soils - all occasionally flooded by storm tides.

Udipsamments[a], Psammaquents[b], Albaqualfs[c], Quartzipsamments[d], Ochraqualfs[e], Fluvaquents[f]

23-E Galveston[a]-Mustang[b]- Rahal[c]
24-E Portalto[d]-Roemer[e]-Veston[f]

VI Soils loamy throughout.

Calciustolls[a], Argiustolls[b], Haplustalfs[c], Ochraqualfs[d], Ustochrepts[e]

25-M Sarnosa[a]-Runge[b]
26-M Willacy[b]-Delfina[c]-Orelia[d]
27-I McAllen[e]-Brennan[c]

VII Soils loamy throughout or with loamy surface layers underlain by clayey layers. Most of the soils have strongly cemented caliche beginning at about 10 to 40 inch depths.

Paleustalfs[a], Paleargids[b], Calciustolls[c], Paleustolls[d], Argiustolls[e]

28-A Delmita[a]-Randado[b]
29-M Olmos[c]-Goliad[d]-Runge[e]
30-M Pernitas[1/c]-Olmos[c]-Goliad[d]

VIII Soils loamy throughout or with loamy surface layers underlain by clayey layers; some clayey throughout. All are somewhat poorly to poorly drained.

Argiaquolls[a], Albaqualfs[b], Glossaqualfs[c], Ochraqualfs[d], Chromuderts[e]

31-M Morey[a]-Anahuac[b]-Frost[c]
32-M Bernard[a]-Morey[a]-Clodine[d]
33-V Vaiden[e]-Acadia[d]-Crowley[b]

IX Saline soils clayey or loamy throughout.

Haplaquolls[a], Fluvaquents[b], Argiaquolls[c], Ochraqualfs[d]

34-M Harris[a]-Ijam[b]
35-M Harris[a]-Morey[c]-Clodine[d]

X Soils clayey throughout; or soils with loamy surface layers underlain by clayey layers. All are saline soils.

Natraqualfs[a], Hapludolls[b]

36-A Livia[a]-Francitas[a]-Matagorda[a]
37-M Pledger[b]-Moreland[b]

XI Soils sandy throughout or with sandy surface layers underlain by loamy layers; or soils with loamy surface layers underlain by clayey layers.

Paleudults[a], Hapludults[b], Paleudalfs[c], Glossaqualfs[d]

38-U Conroe[a]-Darco[a]-Fuquay[a]
39-U Fuquay[a]-Troup[a]-Sacul[b]
40-A Bienville[c]-Wrightsville[d]
41-A Susquehanna[c]-Segno[c]

XII Soils loamy throughout or with loamy surface layers underlain by clayey layers; and soils with sandy surface layers underlain by loamy layers.

Paleudalfs[a], Fragiudalfs[b], Glossaqualfs[c]

42-A Segno[a]-Splendora[b]-Waller[c]
43-A Segno[a]-Hockley[a]-Bernaldo[a]
44-A Erno[b]-Woden[a]-Wrightsville[c]

XIII Soils loamy throughout or soils with loamy surface layers underlain by clayey layers. All soils somewhat poorly or poorly drained

Paleudalfs[a], Glossaqualfs[b], Argiaquolls[c], Ochraqualfs[d], Albaqualfs[e], Fragiudalfs[f]

45-A Sorter[d]-Splendora[f]-Waller[b]
46-A Wockley[1/a]-Katy[a]-Gessner[1/b]
47-M Addicks[1/c]-Clodine[d]-Gessner[1/b]
48-A Falba[1/e]-Aroll[1/e]-Elmina[1/e]

XIV Soils with gravelly, loamy surface layers underlain by clayey layers

Paleustalfs[a]

49-A Witt[1/a]-Tabor[a]

XV Noncalcareous and calcareous, cracking clayey soils and calcareous loamy soils; and strongly acid clayey and loamy soils. All bottom land soils.

Hapludolls[a], Haplustolls[b], Udifluvents[c], Haplaquolls[d], Haplaquepts[e], Fluvaquents[f]

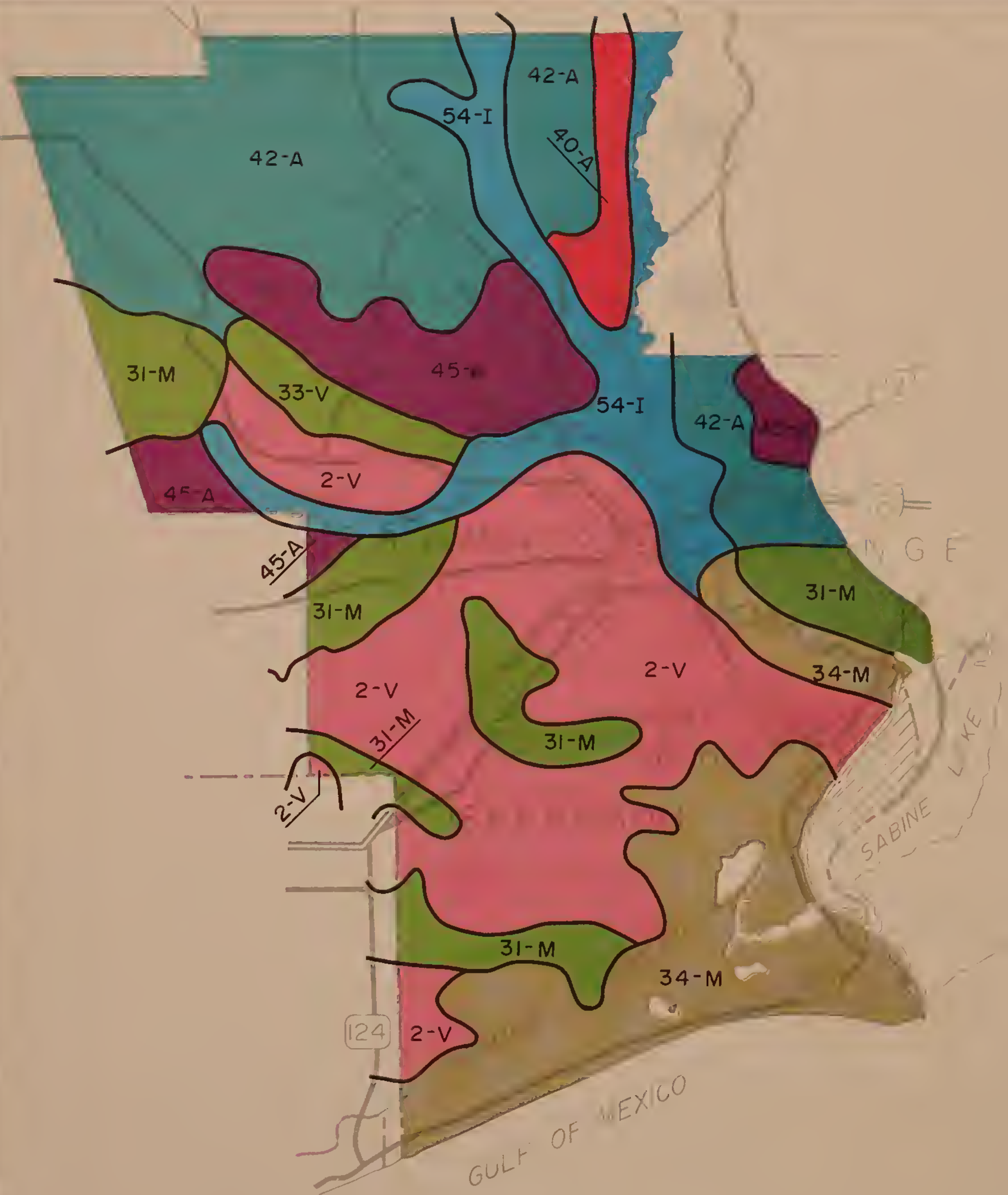
50-M Moreland[a]-Pledger[a]-Norwood[c]
51-M Miller[b]-Norwood[c]-Pledger[a]
52-M Kaufman[d]-Tuscumbia[e], Nahatche[f]
53-M Trinity[d]-Frio[b]
54-I Urbo[e]-Mantachie[f]
55-M Aransas[d]-Sinton[b]-Odem[b]

*The classification at the Great Group level of soils series in each soil association is indicated by the matching small letters.

1/ Field name, subject to change.

5-72 4-R-30896 LEGEND

USDA SCS FT. WORTH TEXAS 1972



N

PLATE 4-5

GENERAL SOIL MAP

TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

0 10 20 MILES
APPROXIMATE SCALE
1:500,000 or 1 inch = 7.891 MILES

Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection

Sheet 5 of 11

4-R-30896

May 1971

4-R-28553D

GENERAL SOIL MAP
TEXAS COASTAL BASINS

LEGEND

ADVANCE COPY—SUBJECT TO CHANGE

Below each main heading a terse description and a list of great groups (i.e. Pelluderts) of soils are given for the one or more related soil associations which follow. The associations are the units delineated on the map. They have hyphenated names made up from names of two or three soil series of major extent within the delineation. Soils very similar as to kind, arrangement and thickness of natural layers or horizons are known as a soil series (i.e. Beaumont). A geographic name local to their occurrence is usually used in identifying them. Soil series in each association are in turn keyed to the appropriate great group, a category of scientific soil classification more definitive and at a level lower than the order. Other soil series not named in an association on the Legend occur in the area delineated, but they are inclusions that occupy relatively minor acreage in the association.

Symbols within delineations on the map relate to soil associations described and classified in the legend. Association symbols consist of consecutive numbers followed by a capital letter.

I Cracking clayey soils; soils with loamy surface layers underlain by cracking clayey layers; and soils loamy throughout, some of which are compact beneath the surface layer.

Pelluderts[a*], Argiaquolls[b], Ochraqualfs[c], Pellusterts[d], Calciustolls[e], Chromusterts[f], Argiustolls[g], Paleustalfs[h], Paleudalfs[i], Chromuderts[j].

1-V Lake Charles[a*]-Bernard[b]-Midland[c]
2-V Beaumont[a]-Morey[b]-Lake Charles[a]
3-V Victoria[d]-Orelia[c]-Clareville[g]
4-V Victoria[d]-Raymondville[e]-Orelia[c]
5-V Ferris[f]-Heiden[f]-Crockett[h]
6-V Heiden[f]-Engle[e]-Klump[1/g]
7-V Heiden[f]-Houston Black[d]-Engle[e]
8-V Garner[a]-Susquehanna[i]-Houston[j]

II Soils with loamy surface layers underlain by cracking, clayey layers; and cracking clayey soils.

Albaqualfs[a], Argiaquolls[b], Pelluderts[c], Paleustalfs[d], Ochraqualfs[e], Chromusterts[f]

9-A Edna[a]-Bernard[b]-Lake Charles[c]
10-A Crockett[d]-Wilson[e]-Heiden[f]

III Soils that are sandy or loamy throughout; or soils with sandy or loamy surface layers underlain by loamy layers.

Paleustalfs[a], Ustipsamments[b], Haplustalfs[c], Paleudalfs[d]

11-A Sarita[a]-Falfurrias[b]-Nueces[a]
12-A Delfina[c]-Nueces[a]
13-A Wockley[1/d]-Kenney[d]-Hockley[d]

IV Soils with sandy or loamy surface layers underlain by clayey layers most of which are very slowly permeable; and soils with thick sandy surface layers underlain by loamy layers of moderately slow permeability.

Albaqualfs[a], Paleudalfs[b], Ochraqualfs[c], Paleustalfs[d], Paleudults[e], Paleustolls[f]

14-A Edna[a]-Katy[b]-Telferner[a]
15-A Stratton[a]-Tabor[d]-Crockett[d]
16-A Orelia[c]-Leming[d]
17-U Trep[e]-Susquehanna[b]
18-A Fordtran[a]-Telferner[a]-Edna[a]
19-A Orelia[c]-Miguel[d]
20-A Miguel[d]-Leming[d]
21-M Weesatche[1/f]-Miguel[d]
22-A Demona[d]-Patilo[d]-Axtell[d]

V Deep sandy soils, or soils with sandy surface layers underlain by loamy or clayey layers; saline clayey and loamy soils - all occasionally flooded by storm tides.

Udipsamments[a], Psammaquents[b], Albaqualfs[c], Quartzipsamments[d], Ochraqualfs[e], Fluvaquents[f]

23-E Galveston[a]-Mustang[b]-Rahal[c]
24-E Portalto[d]-Roemer[e]-Veston[f]

VI Soils loamy throughout.

Calciustolls[a], Argiustolls[b], Haplustalfs[c], Ochraqualfs[d], Ustochrepts[e]

25-M Sarnosa[a]-Runge[b]
26-M Willacy[b]-Delfina[c]-Orelia[d]
27-I McAllen[e]-Brennan[c]

VII Soils loamy throughout or with loamy surface layers underlain by clayey layers. Most of the soils have strongly cemented caliche beginning at about 10 to 40 inch depths.

Paleustalfs[a], Paleargids[b], Calciustolls[c], Paleustolls[d], Argiustolls[e]

28-A Delmita[a]-Randado[b]
29-M Olmos[c]-Goliad[d]-Runge[e]
30-M Pernitas[1/c]-Olmos[c]-Goliad[d]

VIII Soils loamy throughout or with loamy surface layers underlain by clayey layers; some clayey throughout. All are somewhat poorly to poorly drained.

Argiaquolls[a], Albaqualfs[b], Glossaqualfs[c], Ochraqualfs[d], Chromuderts[e]

31-M Morey[a]-Anahuac[b]-Frost[c]
32-M Bernard[a]-Morey[a]-Clodine[d]
33-V Vaiden[e]-Acadia[d]-Crowley[b]

IX Saline soils clayey or loamy throughout.

Haplaquolls[a], Fluvaquents[b], Argiaquolls[c], Ochraqualfs[d]

34-M Harris[a]-Ijam[b]
35-M Harris[a]-Morey[c]-Clodine[d]

X Soils clayey throughout; or soils with loamy surface layers underlain by clayey layers. All are saline soils.

Natraqualfs[a], Hapludolls[b]

36-A Livia[a]-Francitas[a]-Matagorda[a]
37-M Pledger[b]-Moreland[b]

XI Soils sandy throughout or with sandy surface layers underlain by loamy layers; or soils with loamy surface layers underlain by clayey layers.

Paleudults[a], Hapludults[b], Paleudalfs[c], Glossaqualfs[d]

38-U Conroe[a]-Doarco[a]-Fuquay[a]
39-U Fuquay[a]-Troup[a]-Sacul[b]
40-A Bienville[c]-Wrightsville[d]
41-A Susquehanna[c]-Segno[c]

XII Soils loamy throughout or with loamy surface layers underlain by clayey layers; and soils with sandy surface layers underlain by loamy layers.

Paleudalfs[a], Fragiudalfs[b], Glossaqualfs[c]

42-A Segno[a]-Splendora[b]-Waller[c]
43-A Segno[a]-Hockley[a]-Bernaldo[a]
44-A Erno[b]-Woden[a]-Wrightsville[c]

XIII Soils loamy throughout or soils with loamy surface layers underlain by clayey layers. All soils somewhat poorly or poorly drained

Paleudalfs[a], Glossaqualfs[b], Argiaquolls[c], Ochraqualfs[d], Albaqualfs[e], Fragiudalfs[f]

45-A Sorter[d]-Splendora[f]-Waller[b]
46-A Wockley[1/a]-Katy[a]-Gessner[1/b]
47-M Addicks[1/c]-Clodine[d]-Gessner[1/b]
48-A Falba[1/e]-Arol[1/e]-Elmina[1/e]

XIV Soils with gravelly, loamy surface layers underlain by clayey layers

Paleustalfs[a]

49-A Witt[1/a]-Tabor[a]

XV Noncalcareous and calcareous, cracking clayey soils and calcareous loamy soils; and strongly acid clayey and loamy soils. All bottom land soils.

Hapludolls[a], Haplustolls[b], Udifluvents[c], Haplaquolls[d], Haplaquepts[e], Fluvaquents[f]

50-M Moreland[a]-Pledger[a]-Norwood[c]
51-M Miller[b]-Norwood[c]-Pledger[a]
52-M Kaufman[d]-Tuscumbia[e], Nahatche[f]
53-M Trinity[d]-Frio[b]
54-I Urbo[e]-Mantachie[f]
55-M Aransas[d]-Sinton[b]-Odem[b]

*The classification at the Great Group level of soils series in each soil association is indicated by the matching small letters.

1/ Field name, subject to change.

5—72 4—R—30896 LEGEND

USDA-SCS-FT WORTH TEXAS 1972

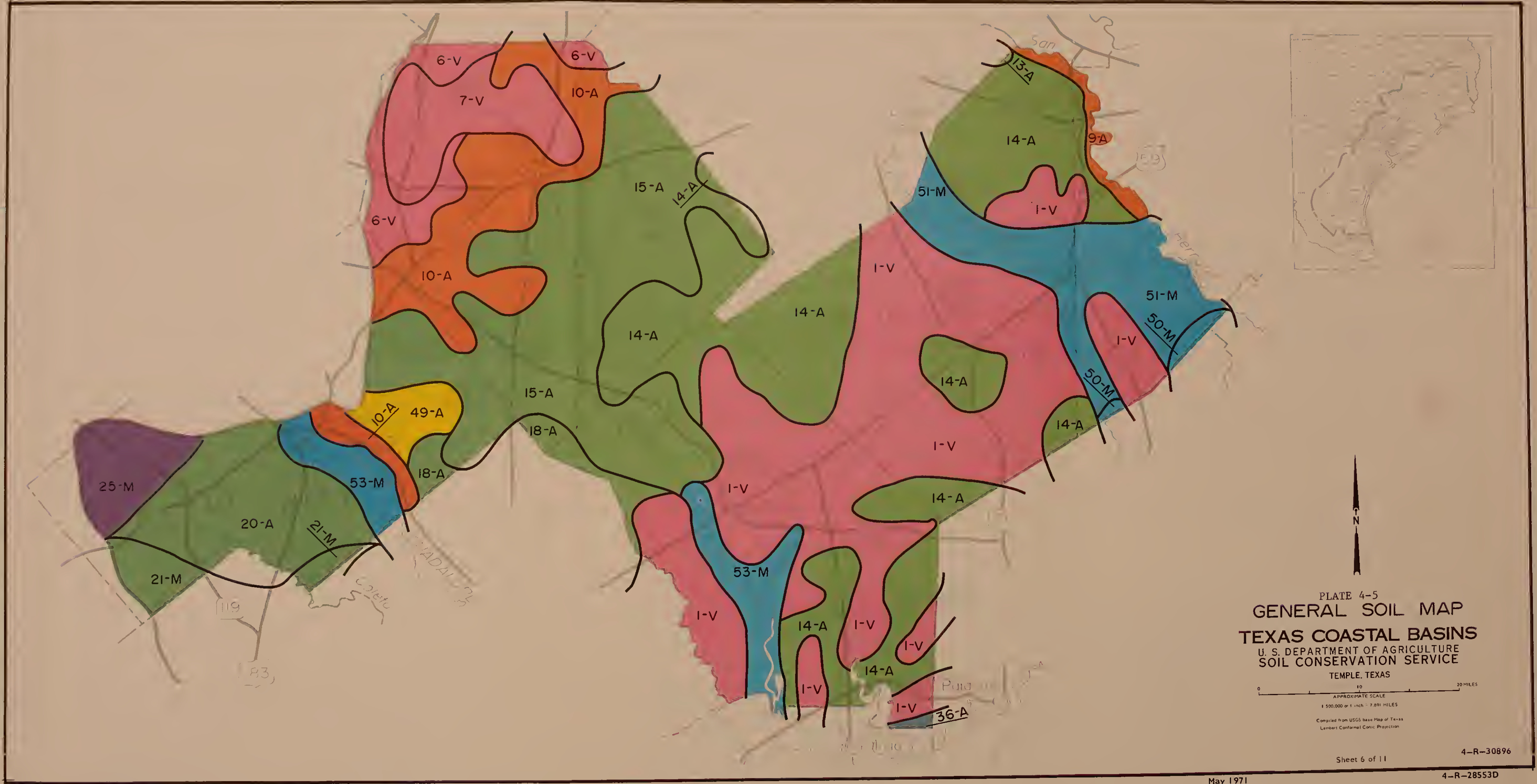


PLATE 4-5
GENERAL SOIL MAP
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

0 10 20 MILES
APPROXIMATE SCALE
1:500,000 or 1 inch = 7.891 MILES

Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection

Sheet 6 of 11

4-R-30896

4-R-28553D

GENERAL SOIL MAP
TEXAS COASTAL BASINS
LEGEND
ADVANCE COPY—SUBJECT TO CHANGE

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Symbols within delineations on the map relate to soil associations described and classified in the legend. Association symbols consist of consecutive numbers followed by a capital letter.

I

Cracking clayey soils; soils with loamy surface layers underlain by cracking clayey layers; and soils loamy throughout, some of which are compact beneath the surface layer.

Pelluderts[a*], Argiaquolls[b], Ochraqualfs[c], Pellusterts[d], Calciustolls[e], Chromusterts[f], Argiustolls[g], Paleustalfs[h], Paleudalfs[i], Chromuderts[j].

1-V Lake Charles[a*]-Bernard[b]-Midland[c]
2-V Beaumont[a]-Morey[b]-Lake Charles[a]
3-V Victoria[d]-Orelia[c]-Clareville[g]
4-V Victoria[d]-Raymondville[e]-Orelia[c]
5-V Ferris[f]-Heiden[f]-Crockett[h]
6-V Heiden[f]-Engle[e]-Klump1/[g]
7-V Heiden[f]-Houston Black[d]-Engle[e]
8-V Garner[a]-Susquehanna[i]-Houston[j]

II

Soils with loamy surface layers underlain by cracking, clayey layers; and cracking clayey soils.

Albaqualfs[a], Argiaquolls[b], Pelluderts[c], Paleustalfs[d], Ochraqualfs[e], Chromusterts[f]

9-A Edna[a]-Bernard[b]-Lake Charles[c]
10-A Crockett[d]-Wilson[e]-Heiden[f]

III

Soils that are sandy or loamy throughout; or soils with sandy or loamy surface layers underlain by loamy layers.

Paleustalfs[a], Ustipsamments[b], Haplustalfs[c], Paleudalfs[d]

11-A Sarita[a]-Falfurrias[b]-Nueces[a]
12-A Delfina[c]-Nueces[a]
13-A Wockley1/[d]-Kenney[d]-Hockley[d]

IV

Soils with sandy or loamy surface layers underlain by clayey layers most of which are very slowly permeable; and soils with thick sandy surface layers underlain by loamy layers of moderately slow permeability.

Albaqualfs[a], Paleudalfs[b], Ochraqualfs[c], Paleustalfs[d], Paleudults[e], Paleustolls[f]

14-A Edna[a]-Katy[b]-Telferner[a]
15-A Stratton[a]-Tabor[d]-Crockett[d]
16-A Orelia[c]-Leming[d]
17-U Trep[e]-Susquehanna[b]
18-A Fordtran[a]-Telferner[a]-Edna[a]
19-A Orelia[c]-Miguel[d]
20-A Miguel[d]-Leming[d]
21-M Weesatche1/[f]-Miguel[d]
22-A Oemona[d]-Patilo[d]-Axtell[d]

V

Oeep sandy soils, or soils with sandy surface layers underlain by loamy or clayey layers; saline clayey and loamy soils - all occasionally flooded by storm tides.

Udipsamments[a], Psammaquents[b], Albaqualfs[c], Quartzipsamments[d], Ochraqualfs[e], Fluvaquents[f]

23-E Galveston[a]-Mustang[b]- Rahal[c]
24-E Portalto[d]-Roemer[e]-Veston[f]

VI

Soils loamy throughout.

Calciustolls[a], Argiustolls[b], Haplustalfs[c], Ochraqualfs[d], Ustochrepts[e]

25-M Sarnosa[a]-Runge[b]
26-M Willacy[b]-Delfina[c]-Orelia[d]
27-I McAllen[e]-Brennan[c]

VII

Soils loamy throughout or with loamy surface layers underlain by clayey layers. Most of the soils have strongly cemented caliche beginning at about 10 to 40 inch depths.

Paleustalfs[a], Paleargids[b], Calciustolls[c], Paleustolls[d], Argiustolls[e]

28-A Delmita[a]-Randado[b]
29-M Olmos[c]-Goliad[d]-Runge[e]
30-M Pernitas1/[c]-Olmos[c]-Goliad[d]

VIII

Soils loamy throughout or with loamy surface layers underlain by clayey layers; some clayey throughout. All are somewhat poorly to poorly drained.

Argiaquolls[a], Albaqualfs[b], Glossaqualfs[c], Ochraqualfs[d], Chromuderts[e]

31-M Morey[a]-Anahuac[b]-Frost[c]
32-M Bernard[a]-Morey[a]-Clodine[d]
33-V Valden[e]-Acadia[d]-Crowley[b]

IX

Saline soils clayey or loamy throughout.

Haplaquolls[a], Fluvaquents[b], Argiaquolls[c], Ochraqualfs[d]

34-M Harris[a]-Ijam[b]
35-M Harris[a]-Morey[c]-Clodine[d]

X

Soils clayey throughout; or soils with loamy surface layers underlain by clayey layers. All are saline soils.

Natraqualfs[a], Hapludolls[b]

36-A Livia[a]-Francitas[a]-Matagorda[a]
37-M Pledger[b]-Moreland[b]

XI

Soils sandy throughout or with sandy surface layers underlain by loamy layers; or soils with loamy surface layers underlain by clayey layers.

Paleudults[a], Hapludults[b], Paleudalfs[c], Glossaqualfs[d]

38-U Conroe[a]-Oarco[a]-Fuquay[a]
39-U Fuquay[a]-Troup[a]-Saculb
40-A Bienville[c]-Wrightsville[d]
41-A Susquehanna[c]-Segno[c]

XII

5oils loamy throughout or with loamy surface layers underlain by clayey layers; and soils with sandy surface layers underlain by loamy layers.

Paleudalfs[a], Fragiudalfs[b], Glossaqualfs[c]

42-A Segno[a]-Splendora[b]-Waller[c]
43-A Segno[a]-Hockley[a]-Bernaldo[a]
44-A Erno[b]-Woden[a]-Wrightsville[c]

XIII

Soils loamy throughout or soils with loamy surface layers underlain by clayey layers. All soils somewhat poorly or poorly drained

Paleudalfs[a], Glossaqualfs[b], Argiaquolls[c], Ochraqualfs[d], Albaqualfs[e], Fragiudalfs[f]

45-A Sorter[d]-Splendora[f]-Waller[b]
46-A Wockley1/[a]-Katy[a]-Gessner1/[b]
47-M Addicks1/[c]-Clodine[d]-Gessner1/[b]
48-A Falba1/[e]-Arol1/[e]-Elmina1/[e]

XIV

Soils with gravelly, loamy surface layers underlain by clayey layers

Paleustalfs[a]

49-A Witt1/[a]-Tabor[a]

XV

Noncalcareous and calcareous, cracking clayey soils and calcareous loamy soils; and strongly acid clayey and loamy soils. All bottom land soils.

Hapludolls[a], Haplustolls[b], Udifluvents[c], Haplaquolls[d], Haplaquepts[e], Fluvaquents[f]

S0-M Moreland[a]-Pledger[a]-Norwood[c]
S1-M Miller[b]-Norwood[c]-Pledger[a]
S2-M Kaufman[d]-Tuscumbia[e], Nahatche[f]
S3-M Trinity[d]-Frio[b]
S4-I Urbo[e]-Mantachie[f]
SS-M Aransas[d]-Sinton[b]-Odem[b]

*The classification at the Great Group level of soils series in each soil association is indicated by the matching small letters.

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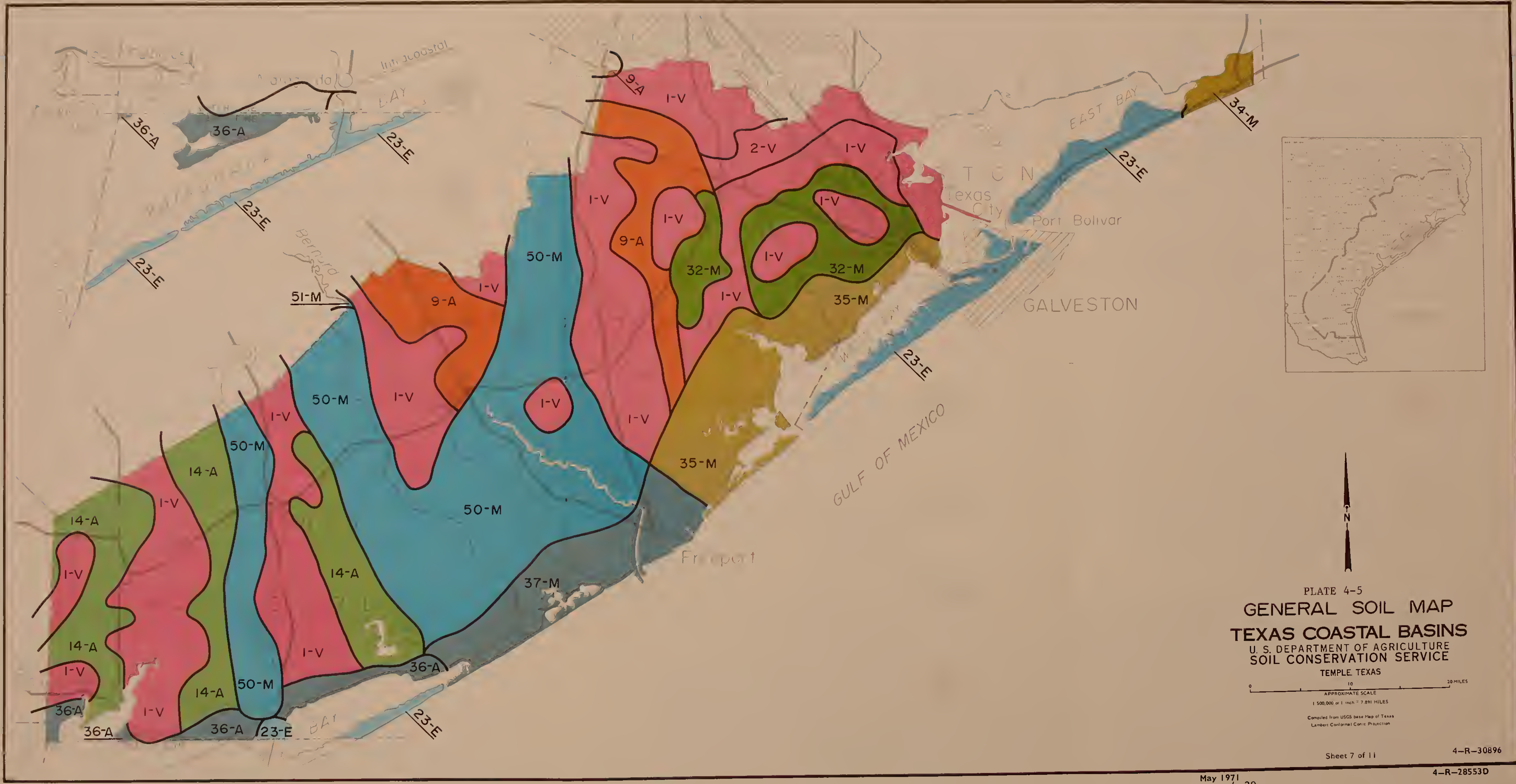
5–72 4–R–30896 LEGEND

USDA SCS FT. WORTH, TEXAS 1972


36-A
23-E
34-M
9-A
1-V
2-V
32-M
35-M
50-M
51-M
14-A
37-M
36-A
Texas City
Port Bolivar
GALVESTON
EAST BAY
GULF OF MEXICO
Freeport
N
PLATE 4-5
GENERAL SOIL MAP
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS
0
10
20 MILES
APPROXIMATE SCALE
1 500,000 or 1 inch = 7.891 MILES
Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection
Sheet 7 of 11
4-R-30896

4-R-28553D

GENERAL SOIL MAP
TEXAS COASTAL BASINS
LEGEND

ADVANCE COPY—SUBJECT TO CHANGE

Below each main heading a terse description and a list of great groups (i.e. Pelluderts) of soils are given for the one or more related soil associations which follow. The associations are the units delineated on the map. They have hyphenated names made up from names of two or three soil series of major extent within the delineation. Soils very similar as to kind, arrangement and thickness of natural layers or horizons are known as a soil series (i.e. Beaumont). A geographic name local to their occurrence is usually used in identifying them. Soil series in each association are in turn keyed to the appropriate great group, a category of scientific soil classification more definitive and at a level lower than the order. Other soil series not named in an association on the Legend occur in the area delineated, but they are inclusions that occupy relatively minor acreage in the association.

Symbols within delineations on the map relate to soil associations described and classified in the legend. Association symbols consist of consecutive numbers followed by a capital letter.

I

Cracking clayey soils; soils with loamy surface layers underlain by cracking clayey layers; and soils loamy throughout, some of which are compact beneath the surface layer.

Pelluderts[a*], Argiaquolls[b], Ochraqualfs[c], Pellusterts[d], Calciustolls[e], Chromusterts[f], Argiustolls[g], Paleustalfs[h], Paleudalfs[i], Chromuderts[j].

1-V Lake Charles[a*]-Bernard[b]-Midland[c]
2-V Beaumont[a]-Morey[b]-Lake Charles[a]
3-V Victoria[d]-Orelia[c]-Clareville[g]
4-V Victoria[d]-Raymondville[e]-Orelia[c]
5-V Ferris[f]-Heiden[f]-Crockett[h]
6-V Heiden[f]-Engle[e]-Klump[1/g]
7-V Heiden[f]-Houston Black[d]-Engle[e]
8-V Garner[a]-Susquehanna[i]-Houston[j]

II

Soils with loamy surface layers underlain by cracking, clayey layers; and cracking clayey soils.

Albaqualfs[a], Argiaquolls[b], Pelluderts[c], Paleustalfs[d], Ochraqualfs[e], Chromusterts[f]

9-A Edna[a]-Bernard[b]-Lake Charles[c]
10-A Crockett[d]-Wilson[e]-Heiden[f]

III

Soils that are sandy or loamy throughout; or soils with sandy or loamy surface layers underlain by loamy layers.

Paleustalfs[a], Ustipsamments[b], Haplustalfs[c], Paleudalfs[d]

11-A Sarita[a]-Falfurrias[b]-Nueces[a]
12-A Delfina[c]-Nueces[a]
13-A Wockley[1/d]-Kenney[d]-Hockley[d]

IV

Soils with sandy or loamy surface layers underlain by clayey layers most of which are very slowly permeable; and soils with thick sandy surface layers underlain by loamy layers of moderately slow permeability.

Albaqualfs[a], Paleudalfs[b], Ochraqualfs[c], Paleustalfs[d], Paleudults[e], Paleustolls[f]

14-A Edna[a]-Katy[b]-Telferner[a]
15-A Stratton[a]-Tabor[d]-Crockett[d]
16-A Orelia[c]-Leming[d]
17-U Trep[e]-Susquehanna[b]
18-A Fordtran[a]-Telferner[a]-Edna[a]
19-A Orelia[c]-Miguel[d]
20-A Miguel[d]-Leming[d]
21-M Weesatche[1/f]-Miguel[d]
22-A Demona[d]-Patilo[d]-Axtell[d]

V

Deep sandy soils, or soils with sandy surface layers underlain by loamy or clayey layers; saline clayey and loamy soils - all occasionally flooded by storm tides.

Udipsamments[a], Psammaquents[b], Albaqualfs[c], Quartzipsamments[d], Ochraqualfs[e], Fluvaquents[f]

23-E Galveston[a]-Mustang[b]-Rahal[c]
24-E Portalto[d]-Roemer[e]-Veston[f]

VI

Soils loamy throughout.

Calciustolls[a], Argiustolls[b], Haplustalfs[c], Ochraqualfs[d], Ustochrepts[e]

25-M Sarnosa[a]-Runge[b]
26-M Willacy[b]-Delfina[c]-Orelia[d]
27-I McAllen[e]-Brennan[c]

VII

Soils loamy throughout or with loamy surface layers underlain by clayey layers. Most of the soils have strongly cemented caliche beginning at about 10 to 40 inch depths.

Paleustalfs[a], Paleargids[b], Calciustolls[c], Paleustolls[d], Argiustolls[e]

28-A Delmita[a]-Randado[b]
29-M Olmos[c]-Goliad[d]-Runge[e]
30-M Pernitas[1/c]-Olmos[c]-Goliad[d]

VIII

Soils loamy throughout or with loamy surface layers underlain by clayey layers; some clayey throughout. All are somewhat poorly to poorly drained.

Argiaquolls[a], Albaqualfs[b], Glossaqualfs[c], Ochraqualfs[d], Chromuderts[e]

31-M Morey[a]-Anahuac[b]-Frost[c]
32-M Bernard[a]-Morey[a]-Clodine[d]
33-V Vaiden[e]-Acadia[d]-Crowley[b]

IX

Saline soils clayey or loamy throughout.

Haplaquolls[a], Fluvaquents[b], Argiaquolls[c], Ochraqualfs[d]

34-M Harris[a]-Ijam[b]
35-M Harris[a]-Morey[c]-Clodine[d]

X

Soils clayey throughout; or soils with loamy surface layers underlain by clayey layers. All are saline soils.

Natraqualfs[a], Hapludolls[b]

36-A Livia[a]-Francitas[a]-Matagorda[a]
37-M Pledger[b]-Moreland[b]

XI

Soils sandy throughout or with sandy surface layers underlain by loamy layers; or soils with loamy surface layers underlain by clayey layers.

Paleudults[a], Hapludults[b], Paleudalfs[c], Glossaqualfs[d]

38-U Conroe[a]-Darco[a]-Fuquay[a]
39-U Fuquay[a]-Troup[a]-Sacul[b]
40-A Bienville[c]-Wrightsville[d]
41-A Susquehanna[c]-Segno[c]

XII

Soils loamy throughout or with loamy surface layers underlain by clayey layers; and soils with sandy surface layers underlain by loamy layers.

Paleudalfs[a], Fragiudalfs[b], Glossaqualfs[c]

42-A Segno[a]-Splendora[b]-Waller[c]
43-A Segno[a]-Hockley[a]-Bernaldo[a]
44-A Erno[b]-Woden[a]-Wrightsville[c]

XIII

Soils loamy throughout or soils with loamy surface layers underlain by clayey layers. All soils somewhat poorly or poorly drained

Paleudalfs[a], Glossaqualfs[b], Argiaquolls[c], Ochraqualfs[d], Albaqualfs[e], Fragiudalfs[f]

45-A Sorter[d]-Splendora[f]-Waller[b]
46-A Wockley[1/a]-Katy[a]-Gessner[1/b]
47-M Addicks[1/c]-Clodine[d]-Gessner[1/b]
48-A Falba[1/e]-Arol[1/e]-Elmina[1/e]

XIV

Soils with gravelly, loamy surface layers underlain by clayey layers

Paleustalfs[a]

49-A Witt[1/a]-Tabor[a]

XV

Noncalcareous and calcareous, cracking clayey soils and calcareous loamy soils; and strongly acid clayey and loamy soils. All bottom land soils.

Hapludolls[a], Haplustolls[b], Udifluvents[c], Haplaquolls[d], Haplaquepts[e], Fluvaquents[f]

50-M Moreland[a]-Pledger[a]-Norwood[c]
51-M Miller[b]-Norwood[c]-Pledger[a]
52-M Kaufman[d]-Tuscumbia[e], Nahatche[f]
53-M Trinity[d]-Frio[b]
54-I Urbo[e]-Mantachie[f]
55-M Aransas[d]-Sinton[b]-Odem[b]

*The classification at the Great Group level of soils series in each soil association is indicated by the matching small letters.

1/ Field name, subject to change.

5-72 4-R-30896 LEGEND

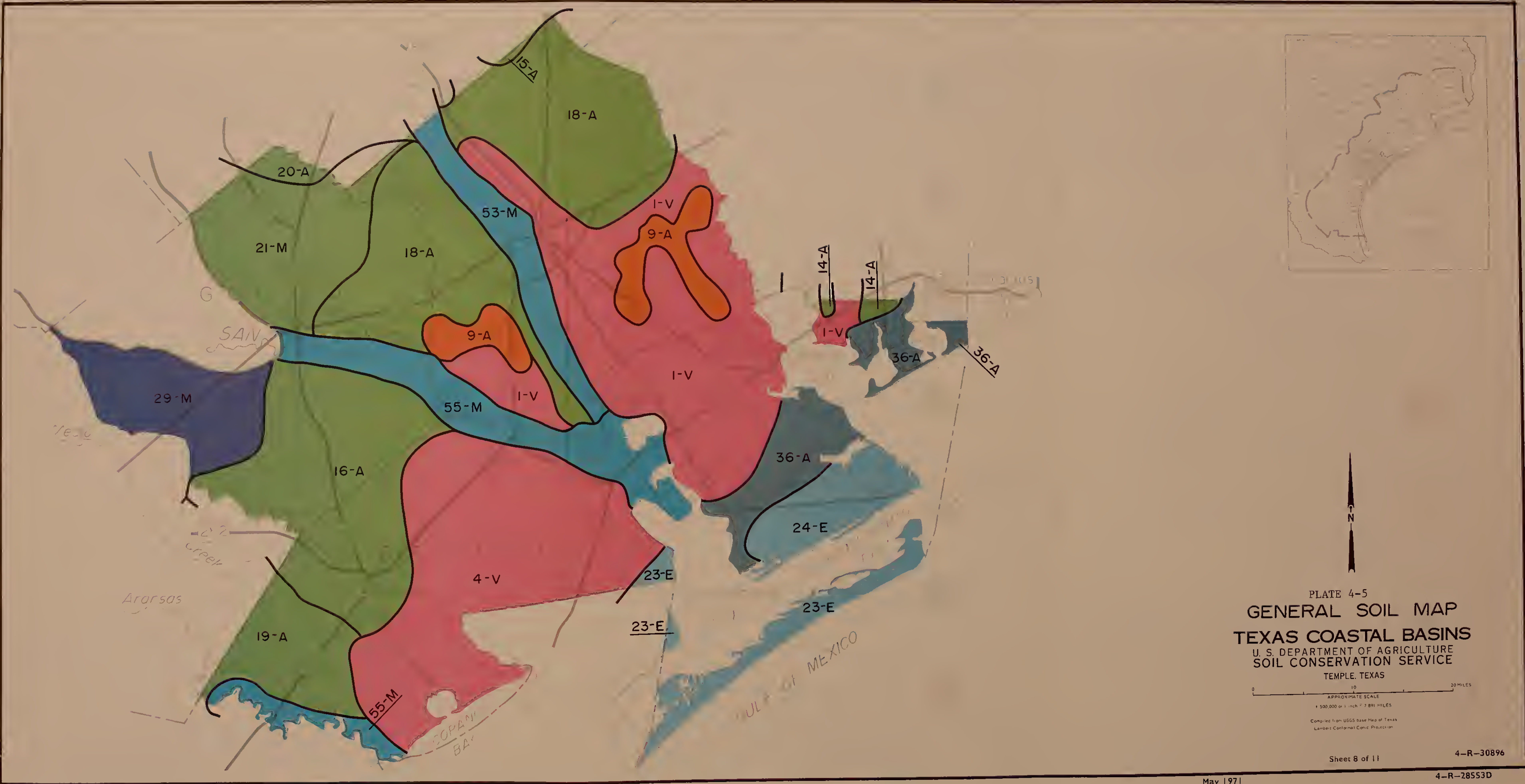


PLATE 4-5

GENERAL SOIL MAP
TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

APPROXIMATE SCALE

Sheet 8 of 11

4-R-30896

May 1971

4-R-28553D

GENERAL SOIL MAP

TEXAS COASTAL BASINS

LEGEND

AOVANCE COPY—SUBJECT TO CHANGE

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Symbols within delineations on the map relate to soil associations described and classified in the legend. Association symbols consist of consecutive numbers followed by a capital letter.

I — Cracking clayey soils; soils with loamy surface layers underlain by cracking clayey layers; and soils loamy throughout, some of which are compact beneath the surface layer.

Pelluderts[a*], Argiaquolls[b], Ochraqualfs[c], Pellusterts[d], Calciustolls[e], Chromusterts[f], Argiustolls[g], Paleustalfs[h], Paleudalfs[i], Chromuderts[j].

1-V Lake Charles[a*]-Bernard[b]-Midland[c]
2-V Beaumont[a]-Morey[b]-Lake Charles[a]
3-V Victoria[d]-Orelia[c]-Clareville[g]
4-V Victoria[d]-Raymondville[e]-Orelia[c]
5-V Ferris[f]-Heiden[f]-Crockett[h]
6-V Heiden[f]-Engle[e]-Klump[1/g]
7-V Heiden[f]-Houston Black[d]-Engle[e]
8-V Garner[a]-Susquehanna[i]-Houston[j]

II — Soils with loamy surface layers underlain by cracking, clayey layers; and cracking clayey soils.

Albaqualfs[a], Argiaquolls[b], Pelluderts[c], Paleustalfs[d], Ochraqualfs[e], Chromusterts[f]

9-A Edna[a]-Bernard[b]-Lake Charles[c]
10-A Crockett[d]-Wilson[e]-Heiden[f]

III — Soils that are sandy or loamy throughout; or soils with sandy or loamy surface layers underlain by loamy layers.

Paleustalfs[a], Ustipsamments[b], Haplustalfs[c], Paleudalfs[d]

11-A Sarita[a]-Falfurrias[b]-Nueces[a]
12-A Delfina[c]-Nueces[a]
13-A Wockley[1/d]-Kenney[d]-Hockley[d]

IV — Soils with sandy or loamy surface layers underlain by clayey layers most of which are very slowly permeable; and soils with thick sandy surface layers underlain by loamy layers of moderately slow permeability.

Albaqualfs[a], Paleudalfs[b], Ochraqualfs[c], Paleustalfs[d], Paleudults[e], Paleustolls[f]

14-A Edna[a]-Katy[b]-Telferner[a]
15-A Stratton[a]-Tabor[d]-Crockett[d]
16-A Orelia[c]-Leming[d]
17-U Trep[e]-Susquehanna[b]
18-A Fordtran[a]-Telferner[a]-Edna[a]
19-A Orelia[c]-Miguel[d]
20-A Miguel[d]-Leming[d]
21-M Weesatche[1/f]-Miguel[d]
22-A Oemona[d]-Patilo[d]-Axtell[d]

V — Oeep sandy soils, or soils with sandy surface layers underlain by loamy or clayey layers; saline clayey and loamy soils - all occasionally flooded by storm tides.

Udipsamments[a], Psammaquents[b], Albaqualfs[c], Quartzipsamments[d], Ochraqualfs[e], Fluvaquents[f]

23-E Galveston[a]-Mustang[b]-Rahal[c]
24-E Portalto[d]-Roemer[e]-Veston[f]

VI — Soils loamy throughout.

Calciustolls[a], Argiustolls[b], Haplustalfs[c], Ochraqualfs[d], Ustochrepts[e]

25-M Sarnosa[a]-Runge[b]
26-M Willacy[b]-Delfina[c]-Orelia[d]
27-I McAllen[e]-Brennan[c]

VII — Soils loamy throughout or with loamy surface layers underlain by clayey layers. Most of the soils have strongly cemented caliche beginning at about 10 to 40 inch depths.

Paleustalfs[a], Paleargids[b], Calciustolls[c], Paleustolls[d], Argiustolls[e]

28-A Oelmita[a]-Randado[b]
29-M Olmos[c]-Goliad[d]-Runge[e]
30-M Pernitas[1/c]-Olmos[c]-Goliad[d]

VIII — Soils loamy throughout or with loamy surface layers underlain by clayey layers; some clayey throughout. All are somewhat poorly to poorly drained.

Argiaquolls[a], Albaqualfs[b], Glossaqualfs[c], Ochraqualfs[d], Chromuderts[e]

31-M Morey[a]-Anahuac[b]-Frost[c]
32-M Bernard[a]-Morey[a]-Clodine[d]
33-V Vaiden[e]-Acadia[d]-Crowley[b]

IX — Saline soils clayey or loamy throughout.

Haplaquolls[a], Fluvaquents[b], Argiaquolls[c], Ochraqualfs[d]

34-M Harris[a]-Ijam[b]
35-M Harris[a]-Morey[c]-Clodine[d]

X — Soils clayey throughout; or soils with loamy surface layers underlain by clayey layers. All are saline soils.

Natraqualfs[a], Hapludolls[b]

36-A Livia[a]-Francitas[a]-Matagorda[a]
37-M Pledger[b]-Moreland[b]

XI — Soils sandy throughout or with sandy surface layers underlain by loamy layers; or soils with loamy surface layers underlain by clayey layers.

Paleudults[a], Hapludults[b], Paleudalfs[c], Glossaqualfs[d]

38-U Conroe[a]-Darco[a]-Fuquay[a]
39-U Fuquay[a]-Troup[a]-Sacul[b]
40-A Bienville[c]-Wrightsville[d]
41-A Susquehanna[c]-Segno[c]

XII — Soils loamy throughout or with loamy surface layers underlain by clayey layers; and soils with sandy surface layers underlain by loamy layers.

Paleudalfs[a], Fragiudalfs[b], Glossaqualfs[c]

42-A Segno[a]-Splendora[b]-Waller[c]
43-A Segno[a]-Hockley[a]-Bernaldo[a]
44-A Erno[b]-Woden[a]-Wrightsville[c]

XIII — Soils loamy throughout or soils with loamy surface layers underlain by clayey layers. All soils somewhat poorly or poorly drained

Paleudalfs[a], Glossaqualfs[b], Argiaquolls[c], Ochraqualfs[d], Albaqualfs[e], Fragiudalfs[f]

45-A Sorter[d]-Splendora[f]-Waller[b]
46-A Wockley[1/a]-Katy[a]-Gessner[1/b]
47-M Addicks[1/c]-Clodine[d]-Gessner[1/b]
48-A Falba[1/e]-Arol[1/e]-Elmina[1/e]

XIV — Soils with gravelly, loamy surface layers underlain by clayey layers

Paleustalfs[a]

49-A Witt[1/a]-Tabor[a]

XV — Noncalcareous and calcareous, cracking clayey soils and calcareous loamy soils; and strongly acid clayey and loamy soils. All bottom land soils.

Hapludolls[a], Haplustolls[b], Udifluvents[c], Haplaquolls[d], Haplaquepts[e], Fluvaquents[f]

50-M Moreland[a]-Pledger[a]-Norwood[c]
51-M Miller[b]-Norwood[c]-Pledger[a]
52-M Kaufman[d]-Tuscumbia[e], Nahatche[f]
53-M Trinity[d]-Frio[b]
54-I Urbo[e]-Mantachie[f]
55-M Aransas[d]-Sinton[b]-Odem[b]

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1/ Field name, subject to change.

5-72 4-R-30896 LEGEND

L FT WORTH TEXAS 1972

May 1971

4-R-28553D

GENERAL SOIL MAP
TEXAS COASTAL BASINS
LEGEND

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6-V Heiden[f]-Engle[e]-Klump[1/g]
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II

Soils with loamy surface layers underlain by cracking, clayey layers; and cracking clayey soils.

Albaqualfs[a], Argiaquolls[b], Pelluderts[c], Paleustalfs[d], Ochraqualfs[e], Chromusterts[f]

9-A Edna[a]-Bernard[b]-Lake Charles[c]
10-A Crockett[d]-Wilson[e]-Heiden[f]

III

Soils that are sandy or loamy throughout; or soils with sandy or loamy surface layers underlain by loamy layers.

Paleustalfs[a], Ustipsamments[b], Haplustalfs[c], Paleudalfs[d]

11-A Sarita[a]-Falfurrias[b]-Nueces[a]
12-A Oelfina[c]-Nueces[a]
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Soils with sandy or loamy surface layers underlain by clayey layers most of which are very slowly permeable; and soils with thick sandy surface layers underlain by loamy layers of moderately slow permeability.

Albaqualfs[a], Paleudalfs[b], Ochraqualfs[c], Paleustalfs[d], Paleudults[e], Paleustolls[f]

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17-U Trep[e]-Susquehanna[b]
18-A Fordtran[a]-Telferner[a]-Edna[a]
19-A Orelia[c]-Miguel[d]
20-A Miguel[d]-Leming[d]
21-M Weesatche[1/f]-Miguel[d]
22-A Oemona[d]-Patilo[d]-Axtell[d]

V

Oeep sandy soils, or soils with sandy surface layers underlain by loamy or clayey layers; saline clayey and loamy soils - all occasionally flooded by storm tides.

Udipsamments[a], Psammaquents[b], Albaqualfs[c], Quartzipsamments[d], Ochraqualfs[e], Fluvaquents[f]

23-E Galveston[a]-Mustang[b]- Rahal[c]
24-E Portalto[d]-Roemere[e]-Veston[f]

VI

Soils loamy throughout.

Calciustolls[a], Argiustolls[b], Haplustalfs[c], Ochraqualfs[d], Ustochrepts[e]

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27-I McAllen[e]-Brennan[c]

VII

Soils loamy throughout or with loamy surface layers underlain by clayey layers. Most of the soils have strongly cemented caliche beginning at about 10 to 40 inch depths.

Paleustalfs[a], Paleargids[b], Calciustolls[c], Paleustolls[d], Argiustolls[e]

28-A Oelmita[a]-Randado[b]
29-M Olmos[c]-Goliad[d]-Runge[e]
30-M Pernitas[1/c]-Olmos[c]-Goliad[d]

VIII

Soils loamy throughout or with loamy surface layers underlain by clayey layers; some clayey throughout. All are somewhat poorly to poorly drained.

Argiaquolls[a], Albaqualfs[b], Glossaqualfs[c], Ochraqualfs[d], Chromuderts[e]

31-M Morey[a]-Anahuac[b]-Frost[c]
32-M Bernard[a]-Morey[a]-Clodine[d]
33-V Vaiden[e]-Acadia[d]-Crowley[b]

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34-M Harris[a]-Ijam[b]
35-M Harris[a]-Morey[c]-Clodine[d]

X

Soils clayey throughout; or soils with loamy surface layers underlain by clayey layers. All are saline soils.

Natraqualfs[a], Hapludolls[b]

36-A Livia[a]-Francitas[a]-Matagorda[a]
37-M Pledger[b]-Moreland[b]

XI

Soils sandy throughout or with sandy surface layers underlain by loamy layers; or soils with loamy surface layers underlain by clayey layers.

Paleudults[a], Hapludults[b], Paleudalfs[c], Glossaqualfs[d]

38-U Conroe[a]-Oarco[a]-Fuquay[a]
39-U Fuquay[a]-Troup[a]-Sacul[b]
40-A Bienville[c]-Wrightsville[d]
41-A Susquehanna[c]-Segno[c]

XII

Soils loamy throughout or with loamy surface layers underlain by clayey layers; and soils with sandy surface layers underlain by loamy layers.

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42-A Segno[a]-Splendora[b]-Waller[c]
43-A Segno[a]-Hockley[a]-Bernaldo[a]
44-A Erno[b]-Woden[a]-Wrightsville[c]

XIII

Soils loamy throughout or soils with loamy surface layers underlain by clayey layers. All soils somewhat poorly or poorly drained

Paleudalfs[a], Glossaqualfs[b], Argiaquolls[c], Ochraqualfs[d], Albaqualfs[e], Fragiudalfs[f]

45-A Sorter[d]-Splendora[f]-Waller[b]
46-A Wockley[1/a]-Katy[a]-Gessner[1/b]
47-M Addicks[1/c]-Clodine[d]-Gessner[1/b]
48-A Falba[1/e]-Aroll[1/e]-Elmina[1/e]

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Paleustalfs[a]

49-A Witt[1/a]-Tabor[a]

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50-M Moreland[a]-Pledger[a]-Norwood[c]
51-M Miller[b]-Norwood[c]-Pledger[a]
52-M Kaufman[d]-Tuscumbia[e], Nahatche[f]
53-M Trinity[d]-Frio[b]
54-I Urbo[e]-Mantachie[f]
55-M Aransas[d]-Sinton[b]-Odem[b]

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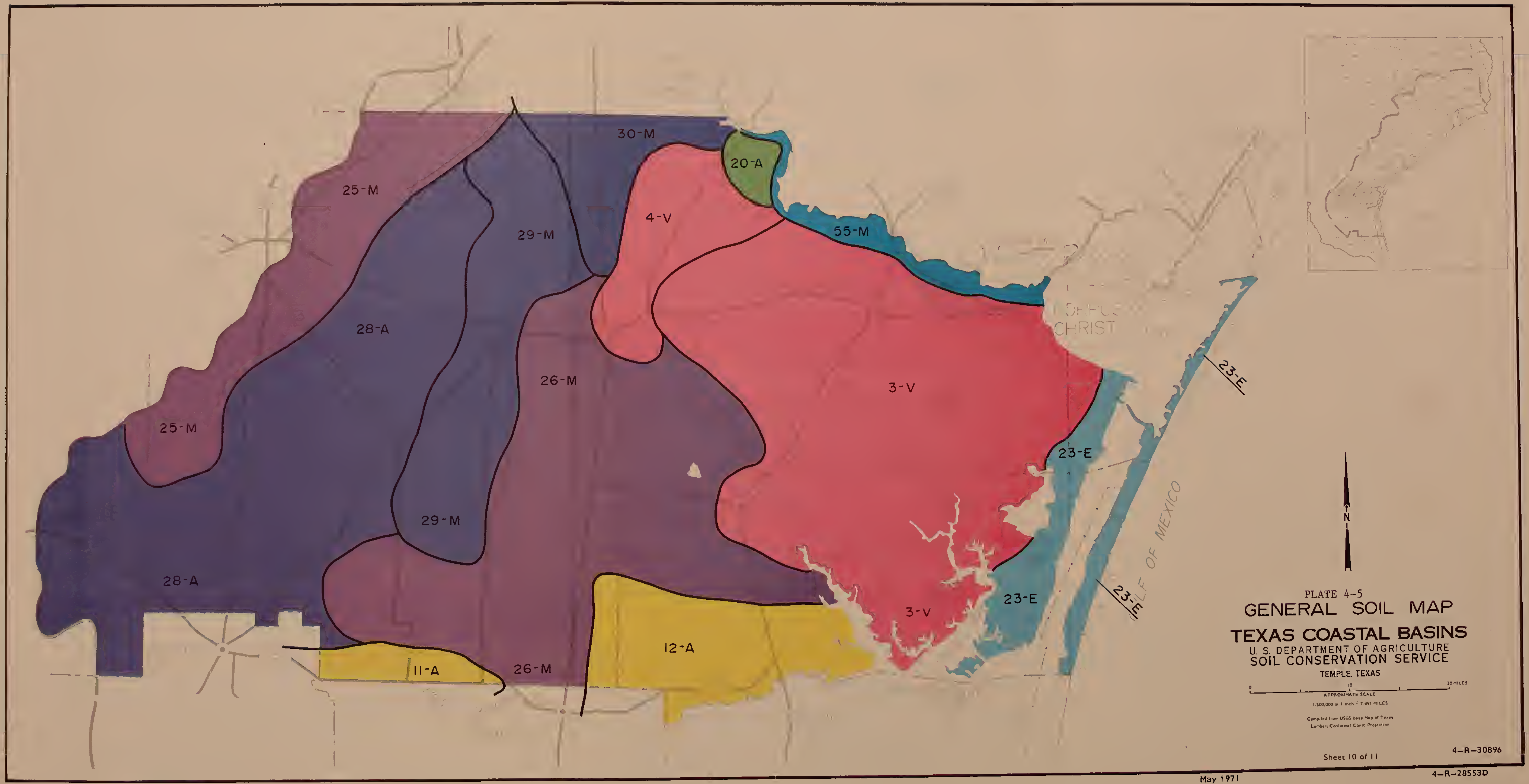
5-72 4-R-30896 LEGEND

SCS FT. WORTH TEXAS 1972



4-R-28553D

May 1971

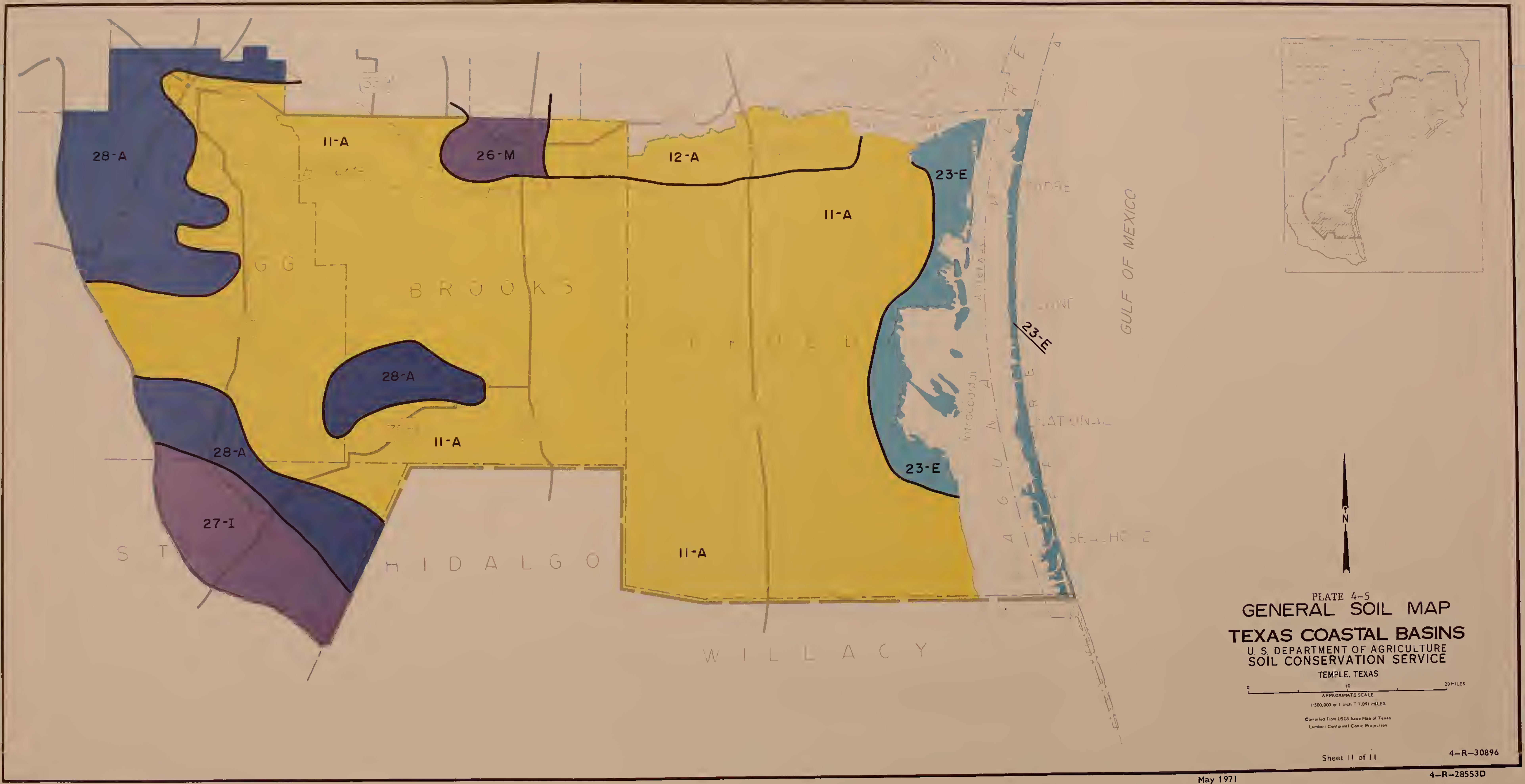


PLATE 4-5
GENERAL SOIL MAP
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

May 1971

4-R-28553D

TABLE 4-2

Soil Group Acreage

Texas Coastal Basins

Group	Acres	Percent of Basin
	----thousands----	
I	5291.0	25.5
II	596.0	2.9
III	2088.0	10.1
IV	3266.0	15.8
V	533.0	2.6
VI	1351.0	6.5
VII	1667.0	8.0
VIII	626.0	3.0
IX	409.0	2.0
X	246.0	1.2
XI	640.0	3.1
XII	1323.0	6.4
XIII	905.0	4.4
XIV	21.0	.1
XV	1771.4	8.5
TOTAL	20,733.4	100.0

Source: Texas Coastal Basins, Volume 2, Appendix A - Soils of the Texas Coastal Basins

Table 4-3

Current Land Use Distribution

Texas Coastal Basins

Land Use	Acres	Percent
Agricultural & Forest		
Cropland	4,420,600	20
Pastureland	2,785,900	12
Rangeland	7,199,200	32
Forest Land	4,435,300 1/	20
Other Land	550,700	3
Subtotal	19,391,700	87
Non-Agricultural		
Urban built-up	1,090,400	5
Federal Land	223,900	1
Water	1,604,900	7
Subtotal	2,919,200	13
TOTAL	22,310,900	100

1/ Includes 152,400 acres National Forest

Source: River Basin Staff, SCS

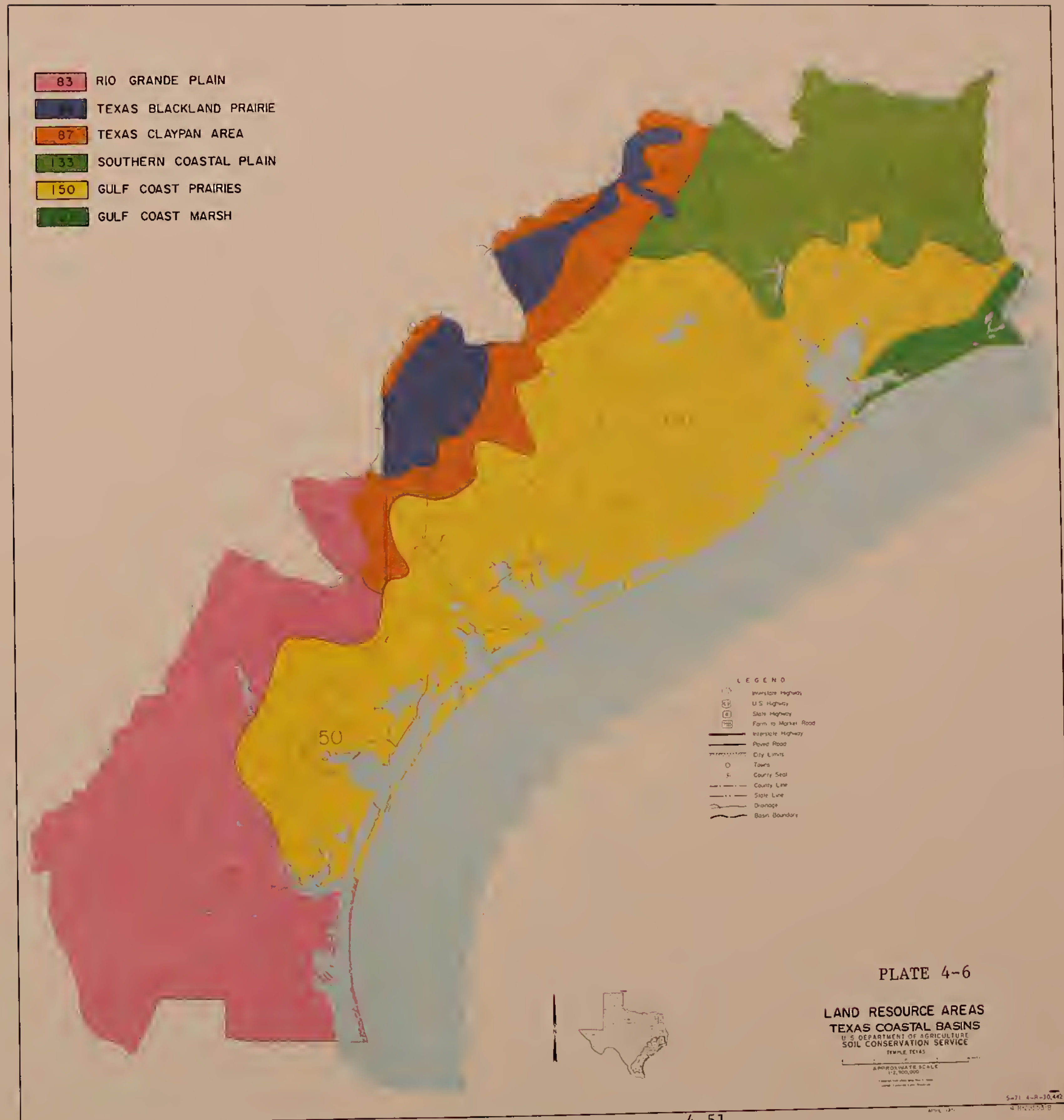

83 RIO GRANDE PLAIN
TEXAS BLACKLAND PRAIRIE
87 TEXAS CLAYPAN AREA
133 SOUTHERN COASTAL PLAIN
150 GULF COAST PRAIRIES
GULF COAST MARSH
150
LEGEND
Interstate Highway
U.S. Highway
State Highway
Farm to Market Road
Interstate Highway
Paved Road
City Limits
Towns
County Seat
County Line
State Line
Drainage
Basin Boundary
LAND RESOURCE AREAS
TEXAS COASTAL BASINS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS
APPROXIMATE SCALE
1:2,900,000
5-71 4-R-30,442

PLATE 4-6

Plate 4-7 shows the present land use within the study area. The delineations on the maps are generalized. The use shown for any given delineation constitutes more than 50 percent of the use within that area.

LAND CAPABILITY

The Soil Conservation Service has found the most dependable way to determine the capability of the land is to make a careful investigation of the land in the field. Scientifically trained technicians have gathered information about the depth, texture, permeability, slope, erosion, inherent fertility, and other characteristics that affect the use, management, and treatment of the land. With these facts and a knowledge of the local climate, land can be classified according to its capability--its ability to produce permanently under specified uses and treatments.

This land capability classification is a systematic arrangement of different kinds of land according to those properties that determine the ability of the land to produce permanently. The degree of permanent limitation imposed by natural land characteristics necessarily affects: (a) the number and complexity of conservation practices; (b) the productivity; and (c) the intensity and manner of land use--for example, the choice of crops on cropland or the amount and season of use on grazing land.

To help define the natural variation of soils for various uses, the SCS has grouped all soils available for agricultural uses into eight land capability classes which are designated by Roman numerals I through VIII, Table 4-4. Generally, the suitability of the soil for agricultural uses decreases from Class I to Class VIII. Soils in the first four classes under good management are generally defined as land suited for cultivation. Classes I to III, with use of proper conservation measures, are recommended for continuous cultivation, and Class IV is recommended for limited cultivation. Soils in Classes V through VIII are generally defined as land limited in use - not generally suited to cultivation, but are best used for pasture, forest, wildlife habitat, recreation, water supply, and aesthetic purposes.

LAND USE POTENTIAL

The 1970 Conservation Needs Inventory shows the Texas Coastal Basins has 19,239,300 acres of agricultural land, Table 4-4.

Sixty-eight percent of this land is suitable for continuous cultivation with proper soil and water conservation measures. Another 13 percent is suitable for limited cultivation with proper treatment. Only inventory land is considered potentially available for agricultural use.

This survey revealed 15,632,500 acres in Classes I through IV. The soil in this area is deemed suitable for cultivation when managed within its capabilities. Class I land, which is suitable for continuous cultivation requiring only good cultural practices, accounts for 840,000 acres; 5,908,700 acres are Class II land which has certain limitations, such as wetness, that restricts the choice of plants and requires a moderate level of conservation treatment; 6,418,700 acres are Class III land which has greater limitations which restrict the choice of cultivated crops and requires special conservation treatment; 2,465,100 acres are Class IV land with soils having very severe limitations that restrict the choice of plants and require very careful management.

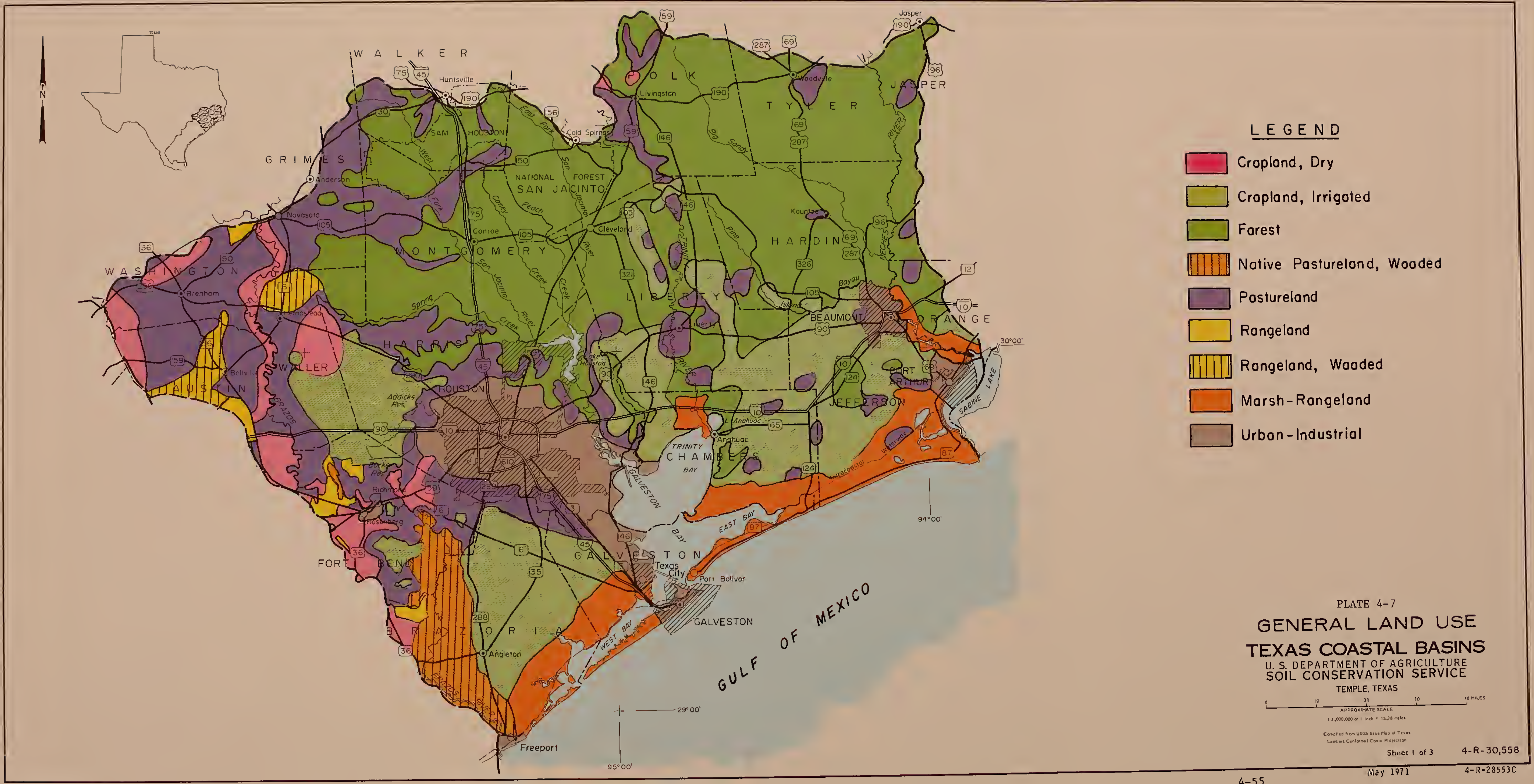
There are 3,606,800 acres, in Classes V through VIII, which are better suited for grassland and forest land because of the risk of damage during cultivation. The limitations are usually impractical or infeasible to eliminate.

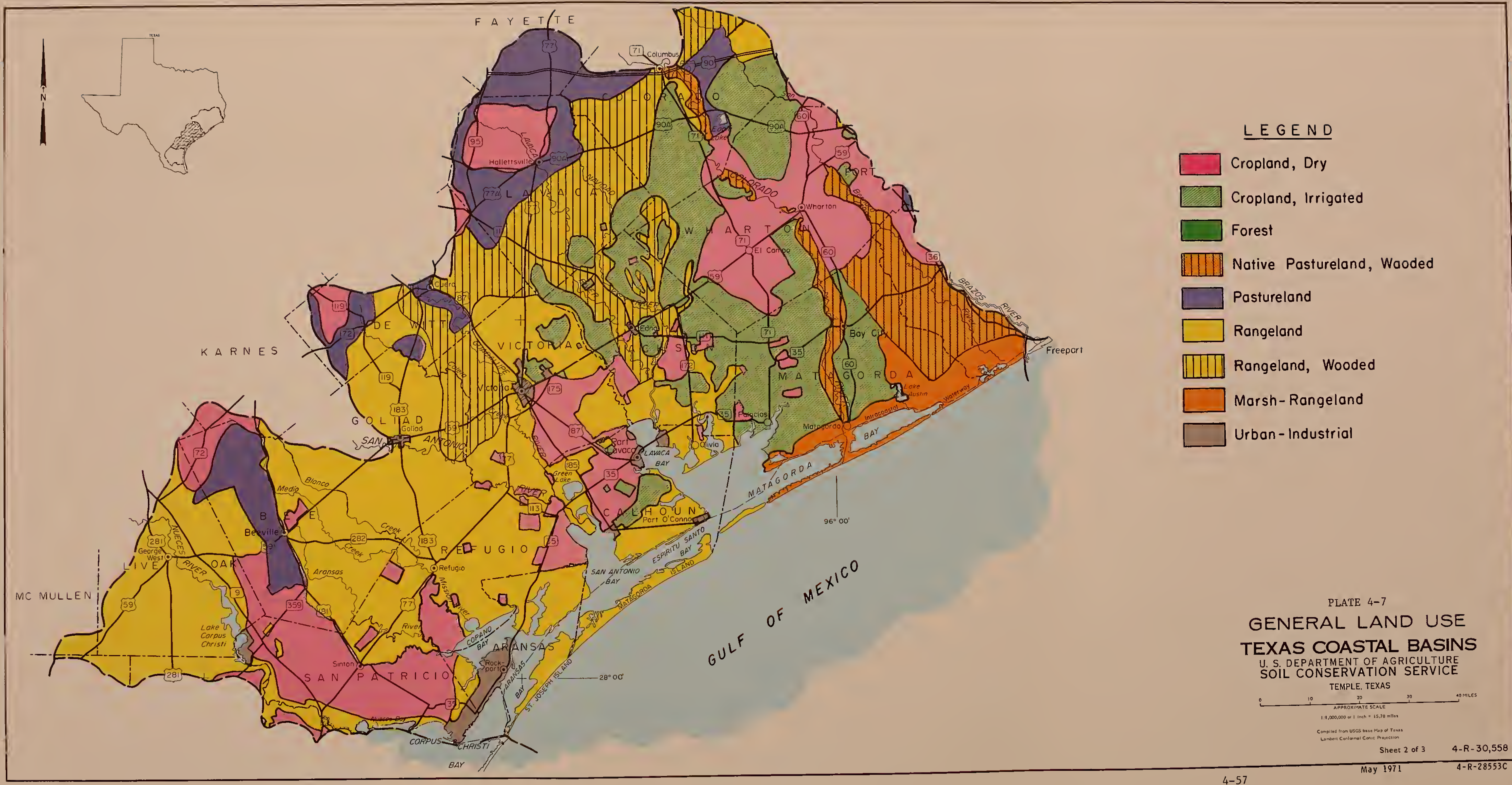
There are 4,420,600 acres of land now supporting cultivated crops. Over 91 percent of these acres are on soils with a capability Class of I, II, or III. There are also 245,400 acres of Class IV in cropland. There are an additional 9,104,800 acres of soils in capability Classes I - III in other uses which could be cultivated with an acceptable level of risk.

There are 6,148,700 acres in grassland (pasture and range) suited for continuous cultivation. Much of this acreage could be put into cultivation by turning under the sod and applying good management practices. The remainder would require the application of measures to eliminate wetness or protect from erosion.

About 136,700 acres of Class I land, 1,272,500 acres of Class II, and 1,267,400 acres of Class III are in forest. This could be readily converted to cropland by clearing the woody vegetation. An additional 853,400 acres of Class IV land could be converted to cropland if special soil and water conservation measures are applied. The risks are greater and the choice of crops is limited.

There are about 112,600 acres of cropland containing soils not suited for cultivation in capability Classes V, VI, and VII.


LEGEND
Cropland, Dry
Cropland, Irrigated
Forest
Native Pastureland, Wooded
Pastureland
Rangeland
Rangeland, Wooded
Marsh-Rangeland
Urban-Industrial
PLATE 4-7
GENERAL LAND USE
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS
Sheet 1 of 3
4-R-30,558
May 1971
4-R-28553C
USDA-SCS-FORT WORTH, TEX. 1971
WALKER
GRIMES
POLK
TYLER
JASPER
WASHINGTON
MONTGOMERY
HARDIN
LIBERTY
ORANGE
WALLER
HARRIS
AUSTIN
JEFFERSON
CHAMBERS
FORT BEND
GALVESTON
BRAZORIA
SAN JACINTO
NATIONAL FOREST
Huntsville
Livingston
Woodville
Jasper
Anderson
Navasota
Brenham
Conroe
Cleveland
Kountze
Beaumont
Liberty
Port Arthur
Houston
Anahuac
Richmond
Rosenberg
Texas City
Port Bolivar
Galveston
Angleton
Freeport
Sabine Lake
Trinity Bay
Galveston Bay
East Bay
West Bay
GULF OF MEXICO
30°00'
29°00'
94°00'
95°00'


LEGEND
Cropland, Dry
Cropland, Irrigated
Forest
Native Pastureland, Wooded
Pastureland
Rangeland
Rangeland, Wooded
Marsh-Rangeland
Urban-Industrial
FAYETTE
COLORADO
LAVACA
WHARTON
FORT
DE WITT
VICTORIA
JACKSON
MATAGORDA
KARNES
GOLIAD
CALHOUN
BEE
REFUGIO
LIVE OAK
MC MULLEN
ARANSAS
SAN PATRICIO
GULF OF MEXICO
Columbus
Hallettsville
Wharton
El Campo
Bay City
Freeport
Edna
Victoria
Goliad
Port Lavaca
Palacios
Matagorda
Olivia
Port O'Connor
Beeville
George West
Refugio
Sinton
Rockport
Lake Corpus Christi
CORPUS CHRISTI BAY
SAN ANTONIO BAY
ESPIRITU SANTO BAY
LAVACA BAY
MATAGORDA BAY
COPANO BAY
ARANSAS BAY
MATAGORDA ISLAND
ST. JOSEPH ISLAND
BRAZOS RIVER
SAN ANTONIO RIVER
NUECES RIVER
Intracoastal Waterway
Lake Austin
96° 00'
28° 00'
PLATE 4-7
GENERAL LAND USE
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS
APPROXIMATE SCALE
Sheet 2 of 3
4-R-30,558
May 1971
4-R-28553C
USDA-SCS-FORT WORTH, TEX 1971

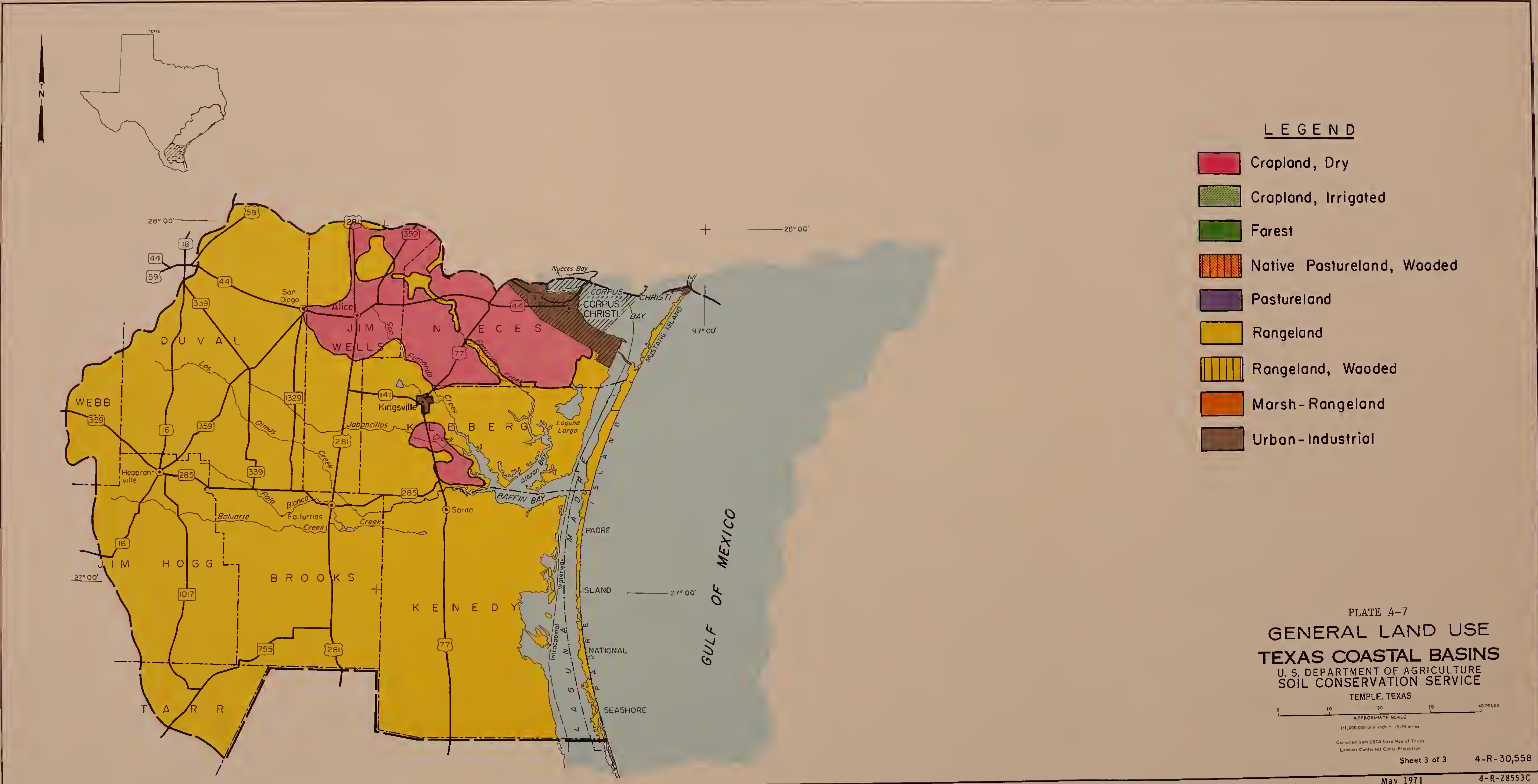


PLATE 4-7

GENERAL LAND USE
TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

Sheet 3 of 3 4-R-30,558

USDA-SCS-FORT WORTH, TEX 1971

May 1971 4-R-28553C

TABLE 4-4

Capability Class Summary
Agricultural and Forest Land 1/

Texas Coastal Basins

Land Capability Class	Total Agricultural Land Acres	Cropland Acres	Pastureland Acres	Rangeland Acres	Forest Land Acres	Other Acres	Distribution Percent
I	840000	236300	347500	99700	136700	19800	4
II	5908700	2200100	975400	1327500	1272500	133200	31
III	6418700	1626200	944600	2454000	1267400	126500	33
Subtotal	13167400	4062600	2267500	3881200	2676600	279500	68
IV	2465100	245400	307300	1020000	853400	39000	13
Subtotal	2465100	245400	307300	1020000	853400	39000	13
V	915700	43000	97000	531500	215600	28600	5
VI	1642000	46300	91500	928900	525900	49400	9
VII	949400	23300	22200	805500	11400	87000	5
VIII	99700	0	400	32100	0	67200	(<1)
Subtotal	3606800	112600	211100	2298000	752900	232200	19
Total	19239300	4420600	2785900	7199200	4282900	550700	100.0

1/ Does not include Federal Land.
Source: CNI 1970.

This small acreage would indicate stability in the cropland based on Classes I - IV land. There is little potential for this type of land other than permanent vegetation.

FOREST LAND

The Texas Coastal Basins contains 4,435,300 acres of forest land which comprises 20 percent of the total area. The general location is shown in Figure 4-2.

The ownership of non-public land is about two-thirds private and one-third industry. Pulp and paper companies are the biggest group of industrial owners. The relatively large share of acreage held by wood-using firms provides a strong base for industrial expansion in east Texas. In turn, the activities on these ownerships provide an example for the other private owners whose management programs are generally less developed. National Forest ownership accounts for 152,400 acres and other public ownerships are only 17,300 acres, Figure 4-3.

Two vastly different forest regions characterize the forest land: (1) Piney Woods Region located to the north and east; (2) Post Oak located to the west and extending southward. Differences in annual rainfall are probably responsible for the inherent tree species and likewise the widely varying capability of the forest land to produce volumes of timber. Piney Woods Region consists of 2,750,000 acres of relatively well-stocked stands of fast growing conifers and some bottom land hardwoods. Post Oak Region consists of 1,235,000 acres of relatively sparse stands of post oak and some hickory, most of which produce insignificant amounts of timber products. There are 270,000 acres of bottom land oak-gum-cypress type outside the Piney Woods Region, scattered along the Brazos, Bernard, Colorado, Lavaca, and Guadalupe Rivers in the predominantly agricultural areas. In the lower one-third of the basin, there are 180,000 acres of widely scattered live oak-cedar-elm-hackberry type.

A major portion of the forest landowners of the Piney Woods Region manage their land for the production of timber products, while most of those of the Post Oak Region manage primarily for wildlife and grazing. Much of the timber markets are located in the Piney Woods Region where the cut can be replenished by fast growing, well-managed stands.

Of the total 2,750,000 acres of commercial forest land within the basin, 1,485,000 acres are at least 70 percent stocked with

FIGURE 4-2

Location of Forest Resource Base
(General Forest-type and Merchantability)

Texas Coastal Basins

(1970)

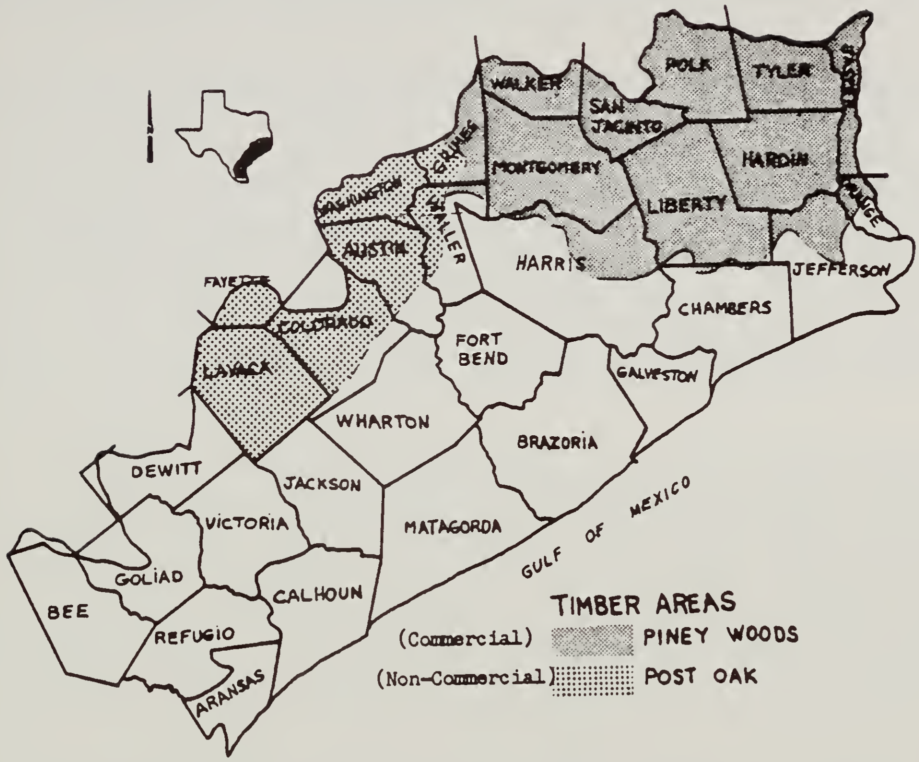
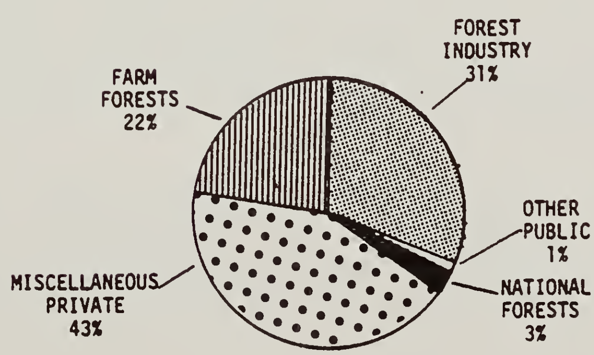


FIGURE 4-3

Forest Ownership

Texas Coastal Basins

(1975)



Miscellaneous Private	1,898,500
Farm Forests	977,000
Forest Industry	1,390,100
National Forests	152,400
Other Public	17,300
	4,435,300 acres

growing trees. An additional 1,012,000 acres are moderately stocked with growing trees, which is adequate to produce a commercial crop of forest products. The remaining 253,000 acres are poorly stocked, Figure 4-4.

During the past decade, the basins' forests increased their product yields from 100 million cubic feet to 118 million cubic feet. This was accomplished despite a loss in forest acreage of an area the size of Houston. Even more surprising is the fact that timber harvests removed only two-thirds of the net annual growth of this diminishing forest. This positive growth/cut relationship has raised the growing stock volume from 3.3 billion cubic feet to 3.6 billion cubic feet. As the growing stock volume increases, so do the associated factors of net annual growth and net allowable cut.

For the purposes of timber production, only the "Piney Woods" portion of the basin is evaluated. Average net annual growth for the Piney Woods counties increased from 43.8 cubic feet per acre in 1964 to 59.2 cubic feet per acre in 1975. Harvest of growing stock for forest products in the same period was 118 million cubic feet. The average annual harvest grew from 32.1 cubic feet per acre in 1964 to 39.2 cubic feet per acre in 1975.

Incomplete utilization, both in the woods and at the mill, is a factor which further contributes to the roundwood demand-supply deficit. These losses will decrease as demands increase, making it more profitable to utilize poor quality portions of the trees.

A total of 37 million cubic feet, or 13.4 cubic feet per acre annually, of the forest resource is left in the woods after harvest. This volume is in stumps, tops, unused sections, and residual trees. Many residues are remote from manufacturing plants. Since most logging residues are of a size and form to make cutting into solid wood products uneconomical, potential uses are primarily for pulp and particle-board.

Much of the timber removed in land clearing operations for home building and agricultural use, for example, is typically piled and burned. Isolated pine stands killed by Southern Pine Beetle during wet conditions are unavailable for utilization.

Not all forest land is suited for grazing. Some forest areas, mainly bottom land hardwoods, are especially vulnerable and need to have grazing reduced or eliminated. Grazing trends are expected to show continued pressure on the Post Oak Region where domestic grazing is already competing with game species for the same resource. As the Piney Woods Region develops even more intensive timber management, the availability of forest range resources is expected to diminish.

MINERAL RESOURCES

Petroleum and natural gas are the most important mineral resources in the Texas Coastal Basins study area. Oil and gas fields are distributed evenly throughout the study area.

Only one true rock quarry is present in the basin. It is located northeast of Mineral in Bee County. The rock is a silicified quartzite and is quarried and crushed in this location.

The mineral resources map, Plate 4-8, shows the location and size of many of the oil and gas fields. They cover approximately 15 percent of the basin area or about 3,300,000 acres.

Caliche, a soft, calcareous rock, is quarried at several points in Kleberg, San Patricio, Jim Wells, and Bee counties for use as concrete aggregate, road material, and screenings.

Dead oyster shell, called reef shell, is an important raw material for a number of Texas industries. Along the coast it serves as a substitute for industrial limestone, which is not available in the study area. It is used in the manufacture of lime, cement, concrete aggregate, and for road material. It is also used in large quantities as an additive to chicken feed to aid in the formation of eggshell and in cattle feed as roughage.

Unoxidized uranium ore (uraninite) in the Oakville sandstone. Formation is mined in Live Oak County from open pit mines north and northeast of Oakville within the study area. Uranium deposits of extremely high grade are located six miles north of Benavides in Duval County.

A plant at Freeport extracts magnesium and bromine from sea water. This is one of the largest industrial operations in Texas and one of the major sources of magnesium in the United States. Recently, bromine extraction and production has ceased.

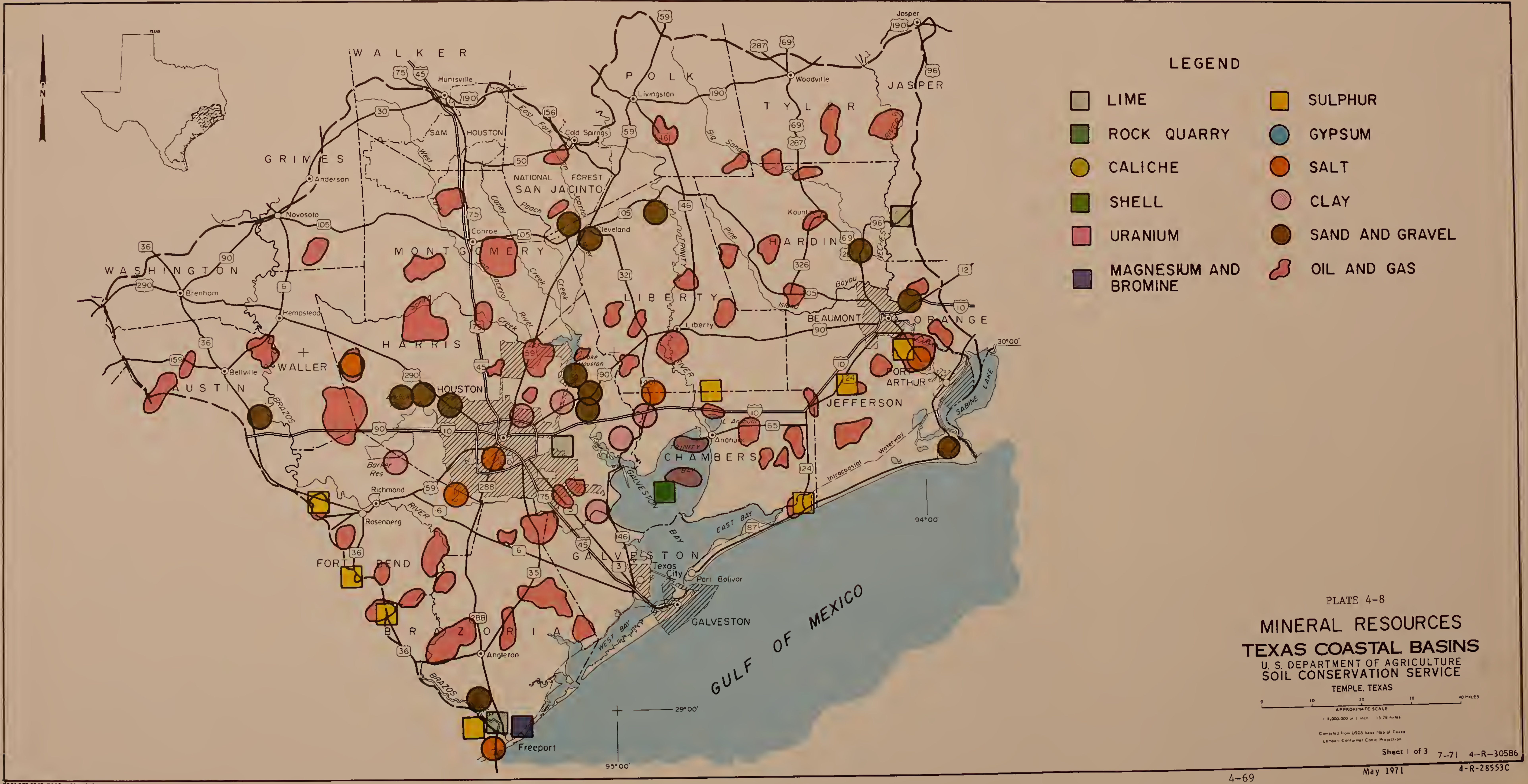
Sulphur is the second most important mineral resource in the study area in terms of value. All mining of sulphur from salt domes in Texas takes place within the Texas Coastal Basins east of the Colorado River. This is the most important sulphur producing area in the United States.

FIGURE 4-4

Area and Percent Stocking of Forest Lands

Texas Coastal Basins

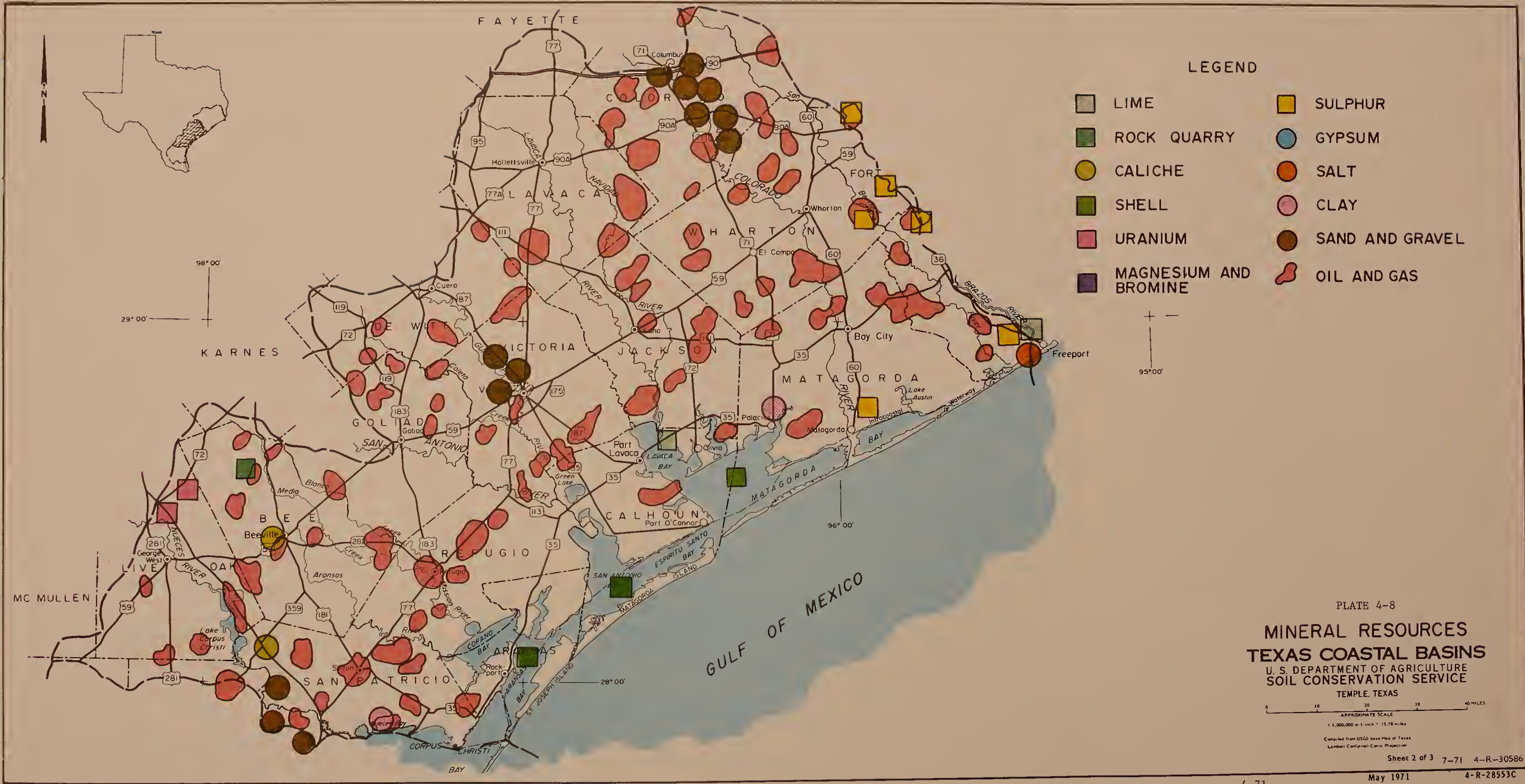
(1965)



USDA-SCS-FORT WORTH TEX. 1971

May 1971

4-R-28553C


LEGEND
LIME
ROCK QUARRY
CALICHE
SHELL
URANIUM
MAGNESIUM AND BROMINE
SULPHUR
GYPSUM
SALT
CLAY
SAND AND GRAVEL
OIL AND GAS
FAYETTE
COLORADO
LAVACA
WHARTON
FORT BEND
BRAZOS
DE WITT
VICTORIA
JACKSON
MATAGORDA
KARNES
GOLIAD
BEE
REFUGIO
CALHOUN
LIVE OAK
MC MULLEN
SAN PATRICIO
ARANSAS
Columbus
Hallettsville
Cuero
Wharton
El Campo
Bay City
Freeport
Edna
Goliad
Port Lavaca
Palacios
Matagorda
Olivia
Port O'Connor
Beeville
George West
Refugio
Sinton
Rockport
Lake Austin
Lake Corpus Christi
Green Lake
LAVACA BAY
MATAGORDA BAY
ESPIRITU SANTO BAY
SAN ANTONIO BAY
COPANO BAY
ARANSAS BAY
CORPUS CHRISTI BAY
Nueces Bay
MATAGORDA ISLAND
ST. JOSEPH ISLAND
Intracoastal Waterway
GULF OF MEXICO
98° 00'
29° 00'
96° 00'
95° 00'
28° 00'
N
PLATE 4-8
MINERAL RESOURCES
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS
0 10 20 30 40 MILES
APPROXIMATE SCALE
Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection
Sheet 2 of 3 7–71 4–R–30586

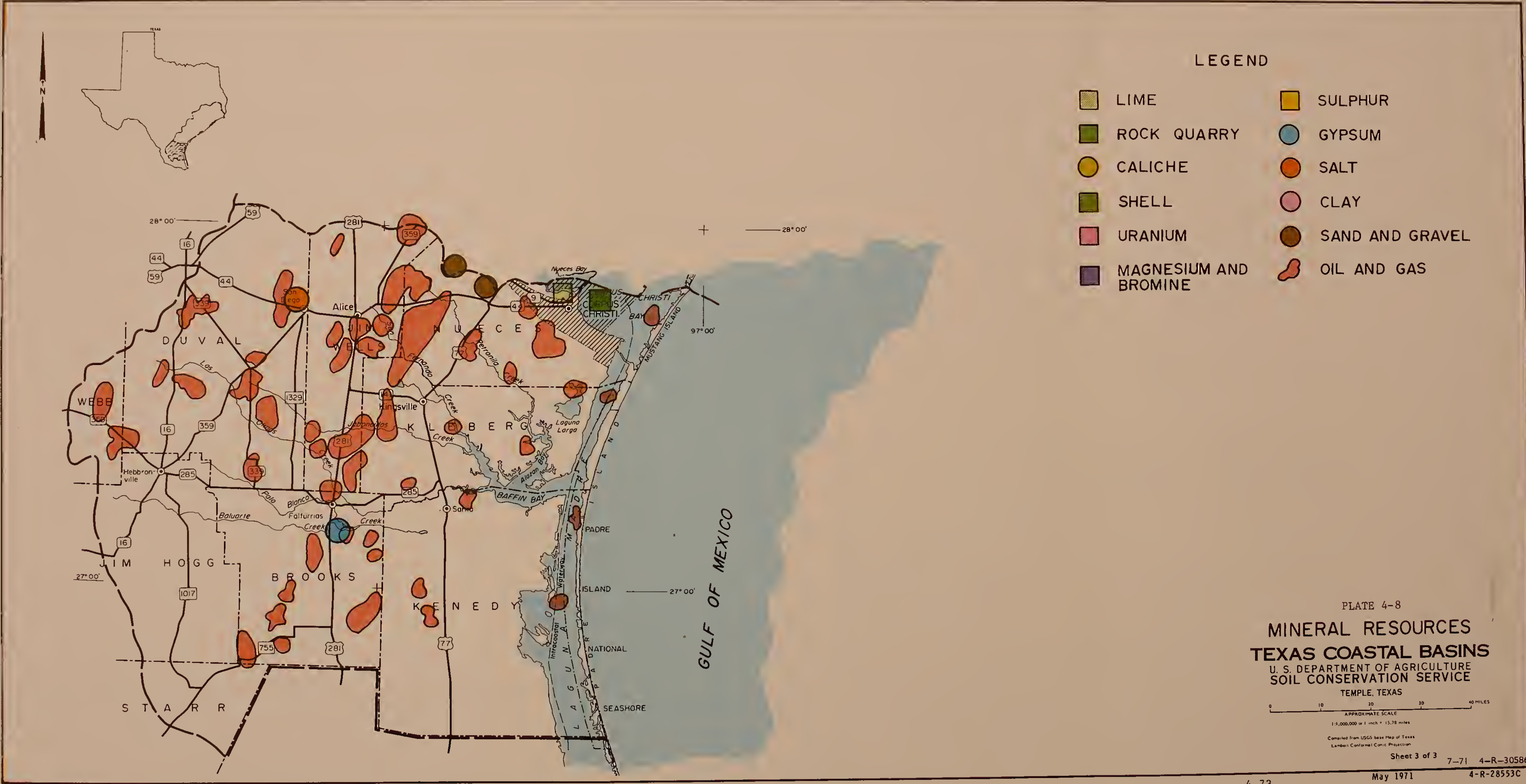


PLATE 4-8

MINERAL RESOURCES
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

One of the largest undeveloped deposits of high-purity gypsum in the Nation is located at Gyp Hill Salt Dome in Brooks County. Approximately 13,000,000 tons are accessible to strip mining and almost unlimited quantities to deeper mining. At the present time no gypsum is produced in the study area.

Salt (sodium chloride) is present in virtually inexhaustible quantities both as rock salt and brine. Rock salt is mined at Hockley Dome near Hockley in Harris County; brine is obtained from wells at Barbers Hill Dome near Mont Belvieu, Bryan Mound Dome near Freeport, Pierce Junction Dome south of Houston, Spindletop Dome southeast of Beaumont, and Blue Ridge Dome near Missouri City. A large brine field is located six miles north of Benavides.

Clay is produced from open pit strip mines in Harris, Wharton, San Patricio, Galveston, Matagorda, and Fort Bend counties, and used in the manufacture of cement, lightweight aggregate, building brick, and structural tile.

The largest concentration of sand and gravel strip mines in the study area is located along the Colorado River between Eagle Lake and Columbus. Significant activity also takes place in Harris County, in Victoria County near Victoria, and along the Nueces River in San Patricio and Nueces counties.

HISTORICAL AND ARCHEOLOGICAL

An inventory of 319 historical and 2,678 archeological recorded sites was compiled in the Texas Coastal Basins. There are many unrecorded in the basins. Plates 4-9 and 4-10 show the general locations of many recorded historical and archeological sites. This inventory is not complete, but does attempt to indicate significant sites, and hopefully will further emphasize the importance of preserving our historic past.

FISH AND WILDLIFE

The Texas Coastal Basins study area contains a rich variety of wildlife. At least seventy species of land mammals inhabit the area. About three hundred and seventy-five species of birds as well as many kinds of reptiles have been identified. These include interesting species which attract sportsmen and wildlife observers from distant locations.

The four categories of wildlife identified were: upland game, wetland game, nongame, and fish.

Major upland game species present in the study area include white-tailed deer, quail, turkey, javelina, mourning dove, gray squirrel, and fox squirrel.

White-tailed deer are found throughout the study area as shown on Plate 4-11.

Bobwhite quail are probably second to deer in importance as upland game species. Plate 4-12 shows the distribution of quail population densities, along with the prime habitat for waterfowl and the location of Federal wildlife refuges in the study area.

Turkeys are most numerous in the brushland counties of the lower coastal area centered in Goliad County. Populations are spotty throughout the rest of the study area. Javelina live in the brushland sector of the lower coastal area and utilize much the same habitat as deer in this area.

Mourning dove habitat generally parallels that of quail. Gray squirrels live primarily in the bottom lands of rivers, large creeks, and flatwoods containing big hardwood timber which is found in the upper part of the study area. Fox squirrels inhabit a much larger area than the gray squirrels. It lives in the same areas as the gray plus upland hardwood and mixed pine-hardwood sites. Population densities of both squirrel species approach one squirrel per two acres in the best habitat areas. Cottontail rabbits are found throughout the study area. Swamp rabbits are found in about the same areas as the gray squirrel. Jackrabbits are found throughout the study area except in the commercial forest of the upper coast.

Wetland wildlife game species present in the study area include waterfowl and furbearers. The Gulf Coast marshes provide one of the most important wintering waterfowl habitats in the United States.

By far the most important game species in the wetlands of the study area are waterfowl, such as mallards, pintails, baldpates, snow, white-fronted, and Canada geese.

Nongame species found in the basin include numerous birds, insectivorous mammals, reptiles, and amphibians.

Many species of wild life are threatened with extinction because of environmental changes which have altered some ecosystems.

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, TEMPLE, TEXAS

PLATE 4-9

DISTRIBUTION OF RECORDED HISTORICAL SITES (JUNE 1975)

TEXAS COASTAL BASINS

0 20 40 60 80 Miles

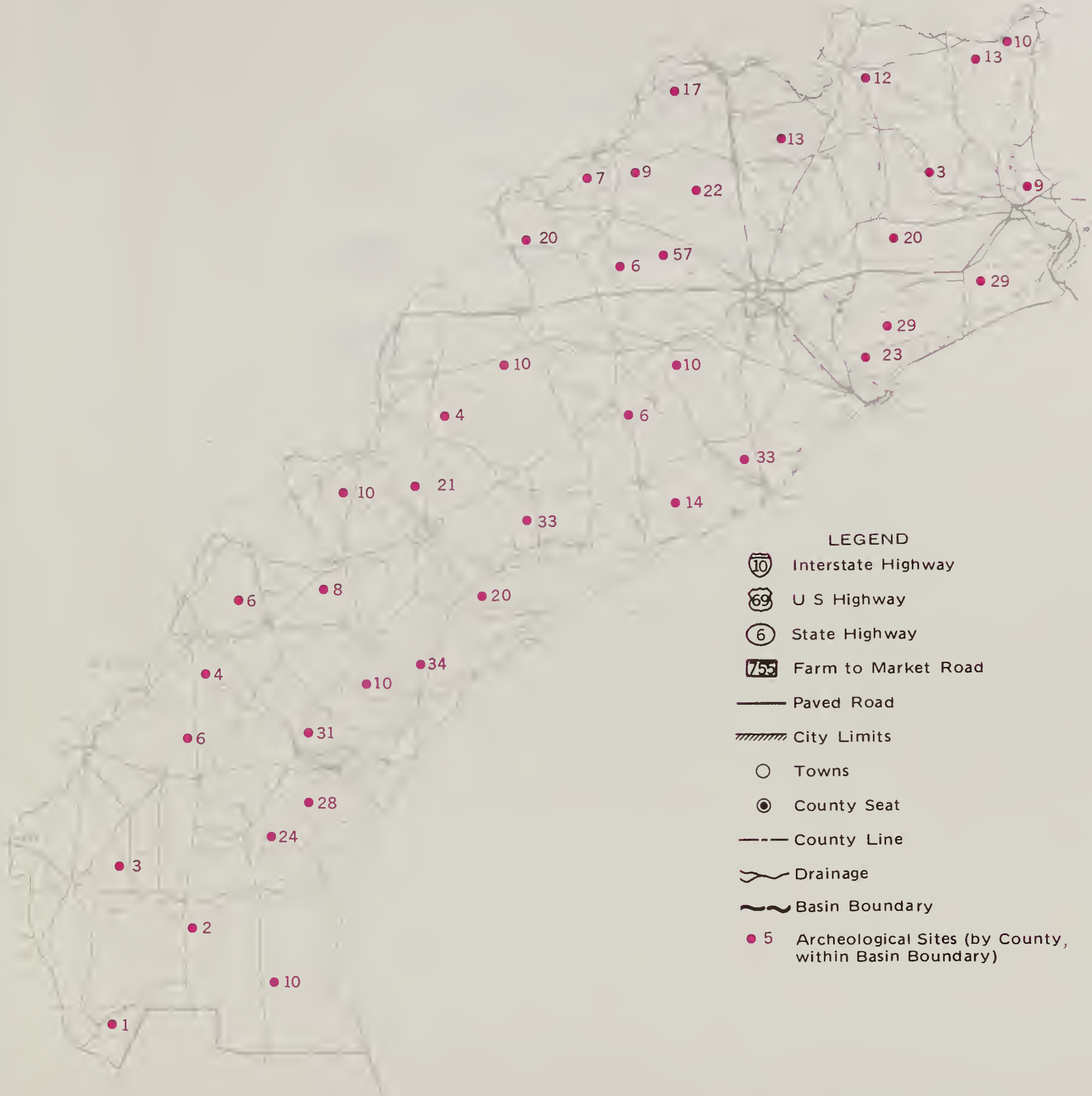
Approximate Scale 1:3,250,000

SOURCE: Data compiled by Texas Coastal Basins Planning Staff.

DECEMBER 1975 4-R-35314

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, TEMPLE, TEXAS



LEGEND

- Interstate Highway (10)
- U S Highway (69)
- State Highway (6)
- Farm to Market Road (755)
- Paved Road
- City Limits
- Towns
- County Seat
- County Line
- Drainage
- Basin Boundary
- ● 5 Archeological Sites (by County, within Basin Boundary)

PLATE 4-10

DISTRIBUTION OF RECORDED ARCHEOLOGICAL SITES (JUNE 1975)

TEXAS COASTAL BASINS

0 20 40 60 80 Miles

Approximate Scale
1:3,250,000

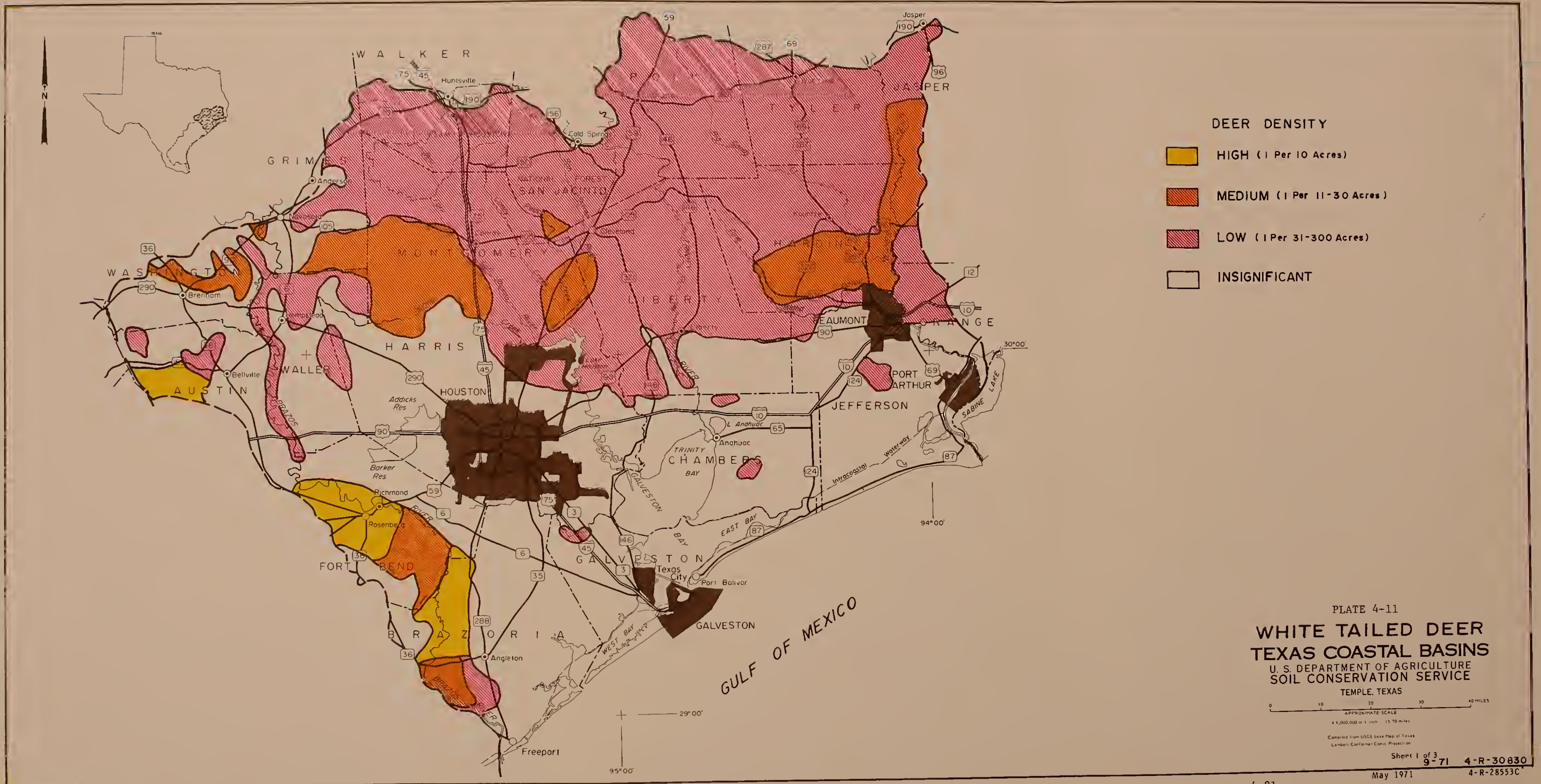
VICINITY MAP

SOURCE: Data compiled by Texas Coastal Basins Planning Staff.

DECEMBER 1975 4-R-35313

APRIL 1971 4-R-28553-B

USDA-SCS-FORT WORTH, TEXAS 1976



USDA-SCS-FORT WORTH, TEX 1971

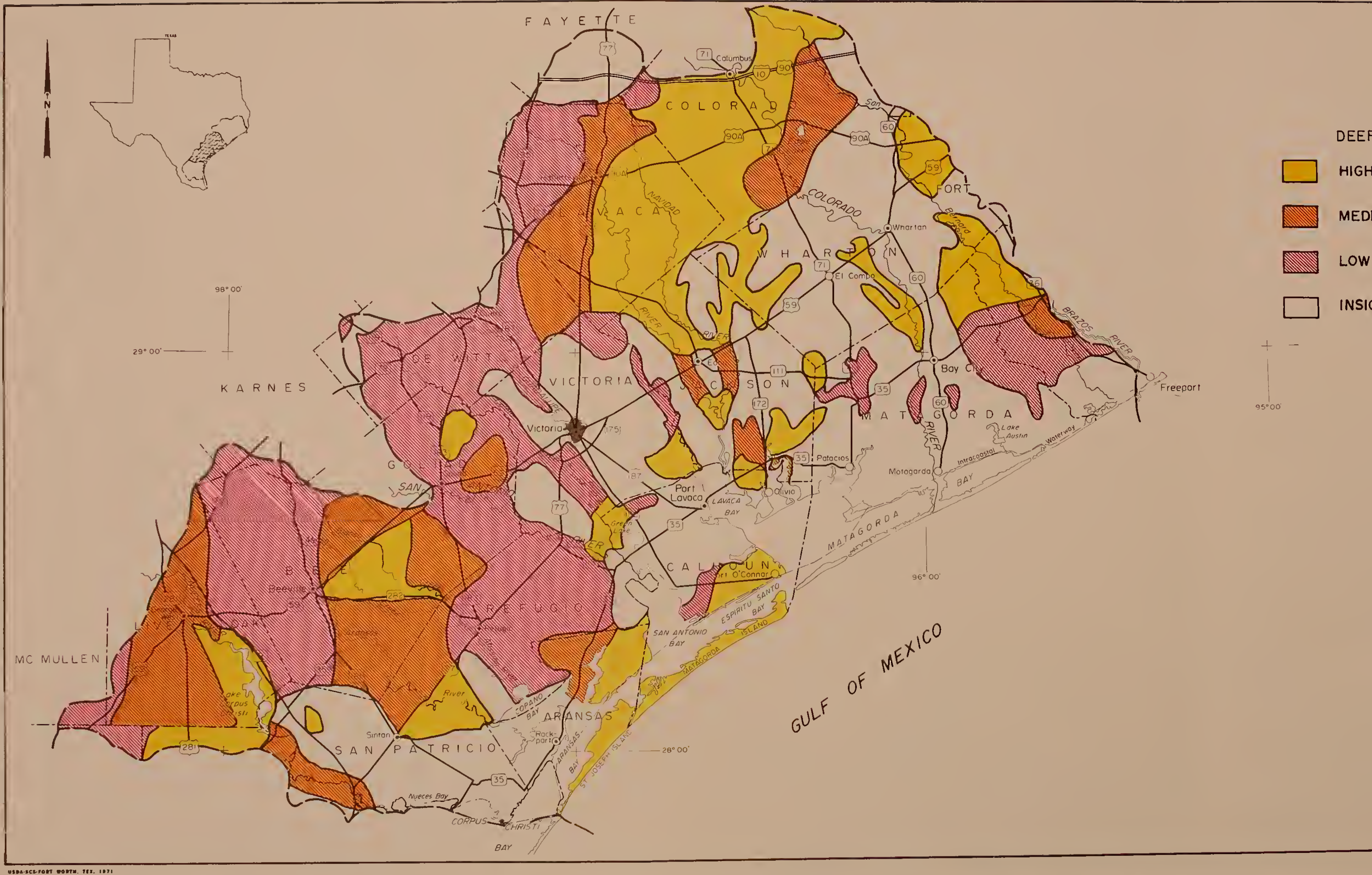


PLATE 4-11

WHITE TAILED DEER
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

0 10 20 30 40 MILES
APPROXIMATE SCALE
1:1,000,000 or 1 inch = 15.78 miles

Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection

Sheet 2 of 3
9-71 4-R-30830
May 1971 4-R-28553C

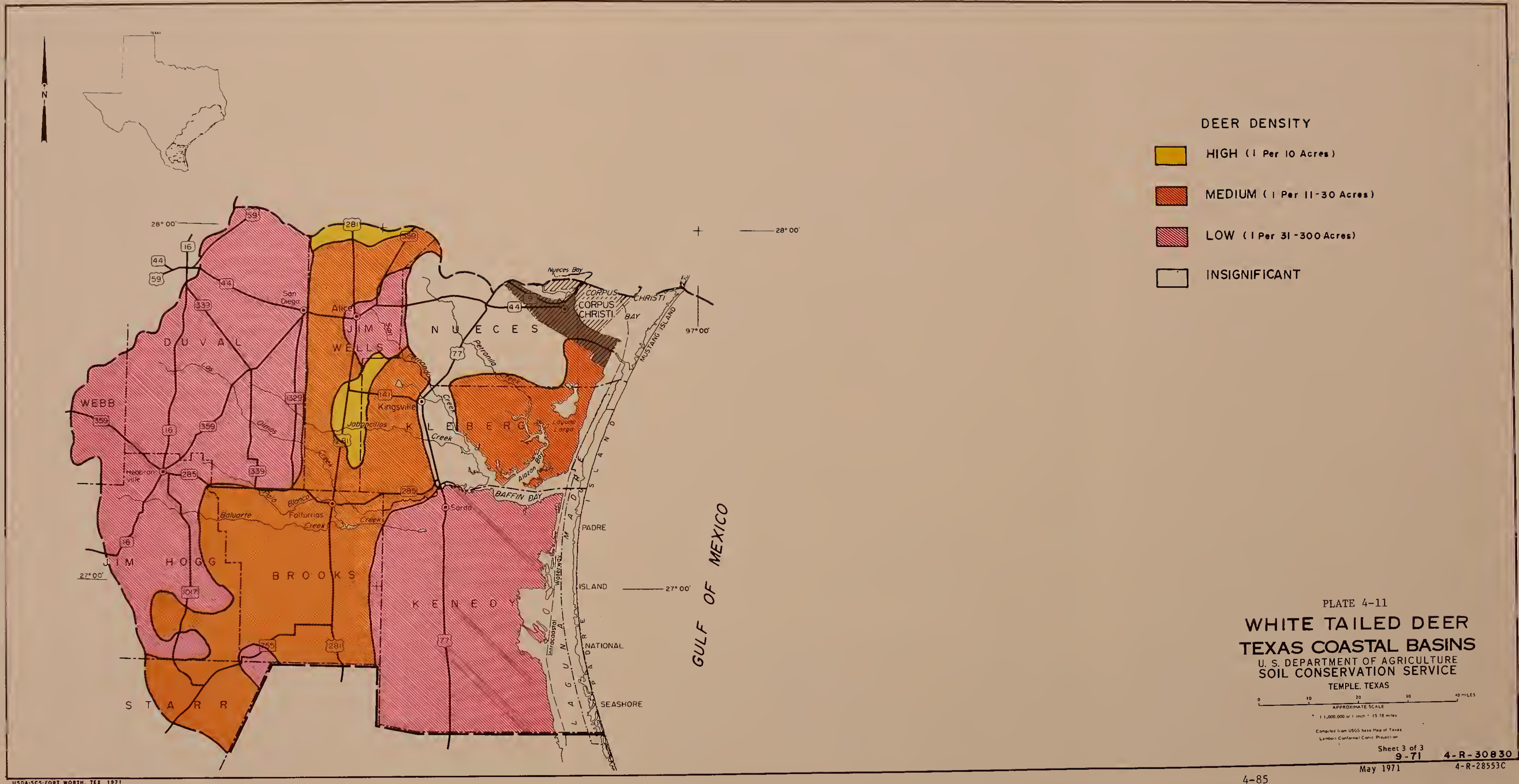


PLATE 4-11

WHITE TAILED DEER
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

Sheet 3 of 3
9-71 4-R-30830
May 1971 4-R-28553C

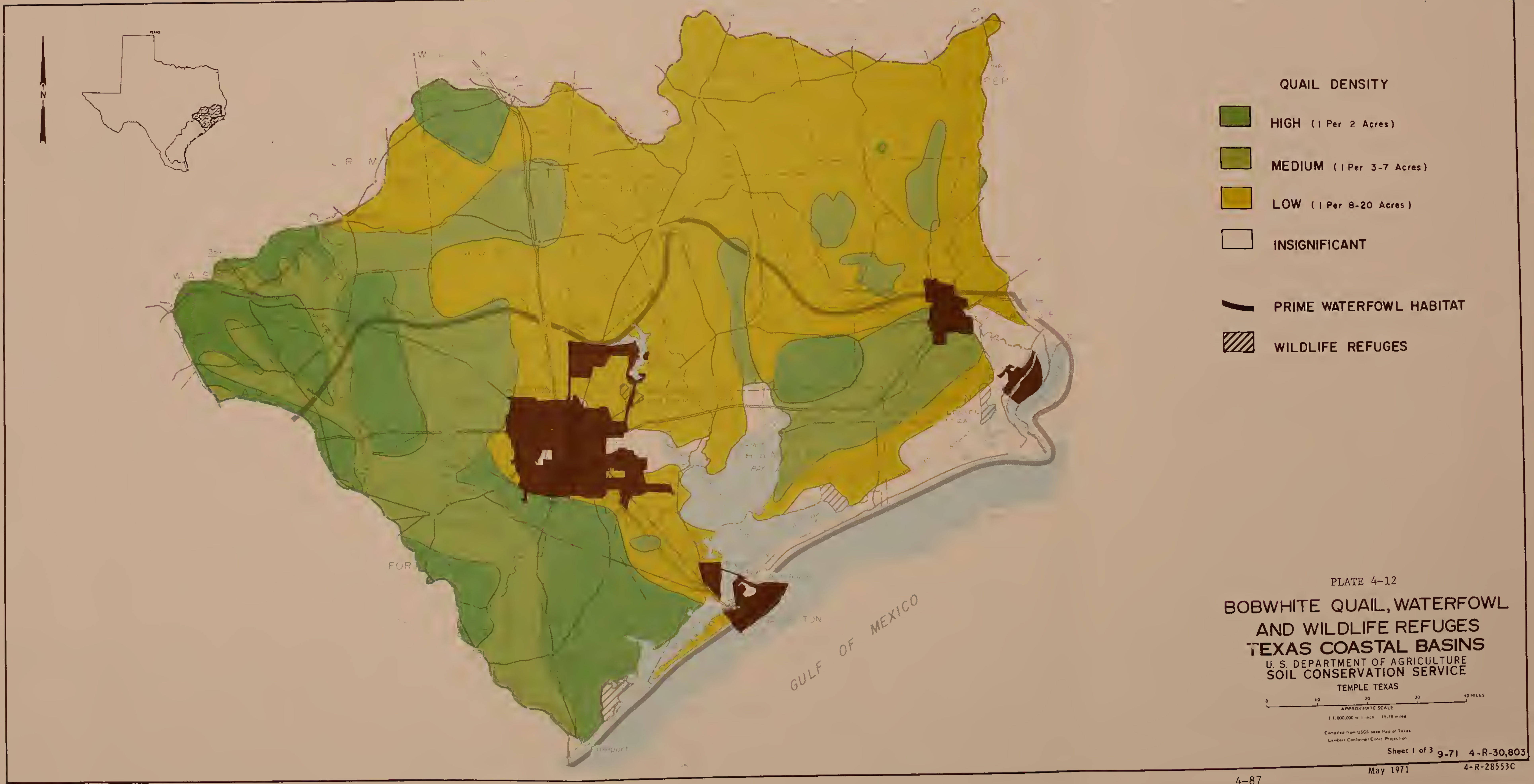


PLATE 4-12

BOBWHITE QUAIL, WATERFOWL AND WILDLIFE REFUGES TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

Sheet 1 of 3 9-71 4-R-30,803

May 1971 4-R-28553C

USDA SCS-FORT WORTH TEX 1973

PLATE 4-12

BOBWHITE QUAIL, WATERFOWL AND WILDLIFE REFUGES
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

May 1971

USDA-SCS-FORT WORTH, TEX. 1973

PLATE 4-12

BOBWHITE QUAIL, WATERFOWL AND WILDLIFE REFUGES TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

0 10 20 30 40 MILES
APPROXIMATE SCALE

Sheet 3 of 3 9-71 4-R-30,803

May 1971 4-R-28553C

USDA-SCS-FORT WORTH, TEX. 1973

There are remnant populations of many of these rare and endangered species within the Texas Coastal Basins. The following species have been designated as rare and endangered by the U.S. Fish and Wildlife Service:

Red wolf
Southern bald eagle
American peregrine falcom
Prairie falcon
Backman's warbler
Whooping crane
Attwater's greater prairie chicken
Southern red-cockaded woodpecker
American ivory-billed woodpecker
American alligator
Houston toad

In addition, the following species which may be found in the study area are considered by the Texas Parks and Wildlife Department to be rare and endangered within Texas:

River otter
Ocelot
Jaguarundi
Black-bellied tree duck
Brown pelican
Olivaceous cormorant

VEGETATION

The Texas Coastal Basins have a wide variety of vegetation due to diverse topography, climate, and soils. Plants vary from large pine trees in the northeast to thorny brush and prickly pear in the southwest. In between is a vast section of prairies flanked by a narrow strip of marsh along the coast. To the north of the coastal prairies is an area containing strips of upland oak intermittent with upland prairies. Much of the post oak timber has been cleared and planted to improved pasture grasses.

The forested area is covered by a pine-hardwood complex with pine dominating the uplands and hardwoods more prevalent along stream flood plains. Many species of woody plants form an understory on bottom land sites. Sumac, sweet bay, rattan, hickory, magnolia, and other species as well as native grasses and legumes are found in bottom land plant communities. In the proposed Big Thicket National Scenic Area there are hundreds of plant species, many of which are extremely rare and worthy of protection.

Along the upper edge of the study area there is an intermittent pattern of upland oak vegetation and upland prairie grasses. Blackjack oak, post oak, and yaupon are the primary woody species while bluestems, smut grass, yankeeweed, and Texas wintergrass are found on prairie sites. Some excellent improved pastures of coastal bermuda grass have been established on land which was previously in cultivation.

Plate 4-13 shows the general locations of forest and brushland vegetation types in the basin.

The Texas Organization for Endangered Species (TOES) recognizes over 100 species of threatened or endangered plants possibly occurring in the Texas Coastal Basins study area. These species are listed in their publication and include the various species listed by the Smithsonian Institute and the Rare Plant Center at the University of Texas, Austin.

RECREATION

The Texas Parks and Wildlife Department's Comprehensive Planning Branch inventoried the recreational parks in 1969 by county for the State of Texas. The parks and their sizes, within the study area, are shown in Table 4-5 by their administrating entity. These parks represent varying degrees of development and quality, encompassing a combined total of 189,654 acres, which is about one acre for each 16 inhabitants, or one percent of the total land in the study area. This inventory for the basins did not include the Big Thicket Biological Preserve, wildlife refuges, and hunting on private lands. Only the developed portion of Sam Houston National Forest was included.

The number of facilities presently developed for selected activities and the activity days furnished by these facilities are shown in Table 4-6.

The major recreational areas and tourist attractions located in the basin are shown in Table 4-7 with their general location displayed on Plate 4-14.

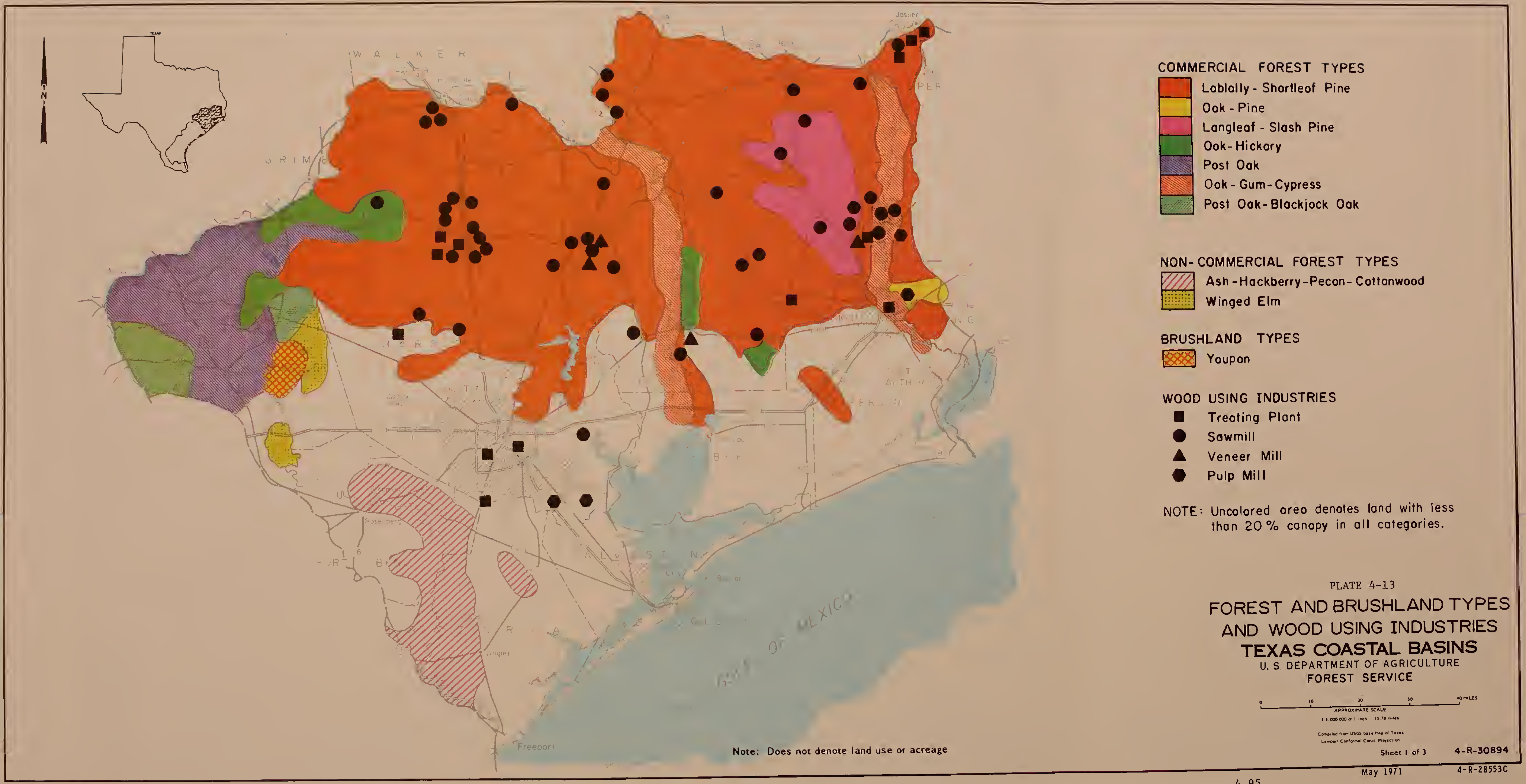


PLATE 4-13

FOREST AND BRUSHLAND TYPES AND WOOD USING INDUSTRIES
TEXAS COASTAL BASINS
U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

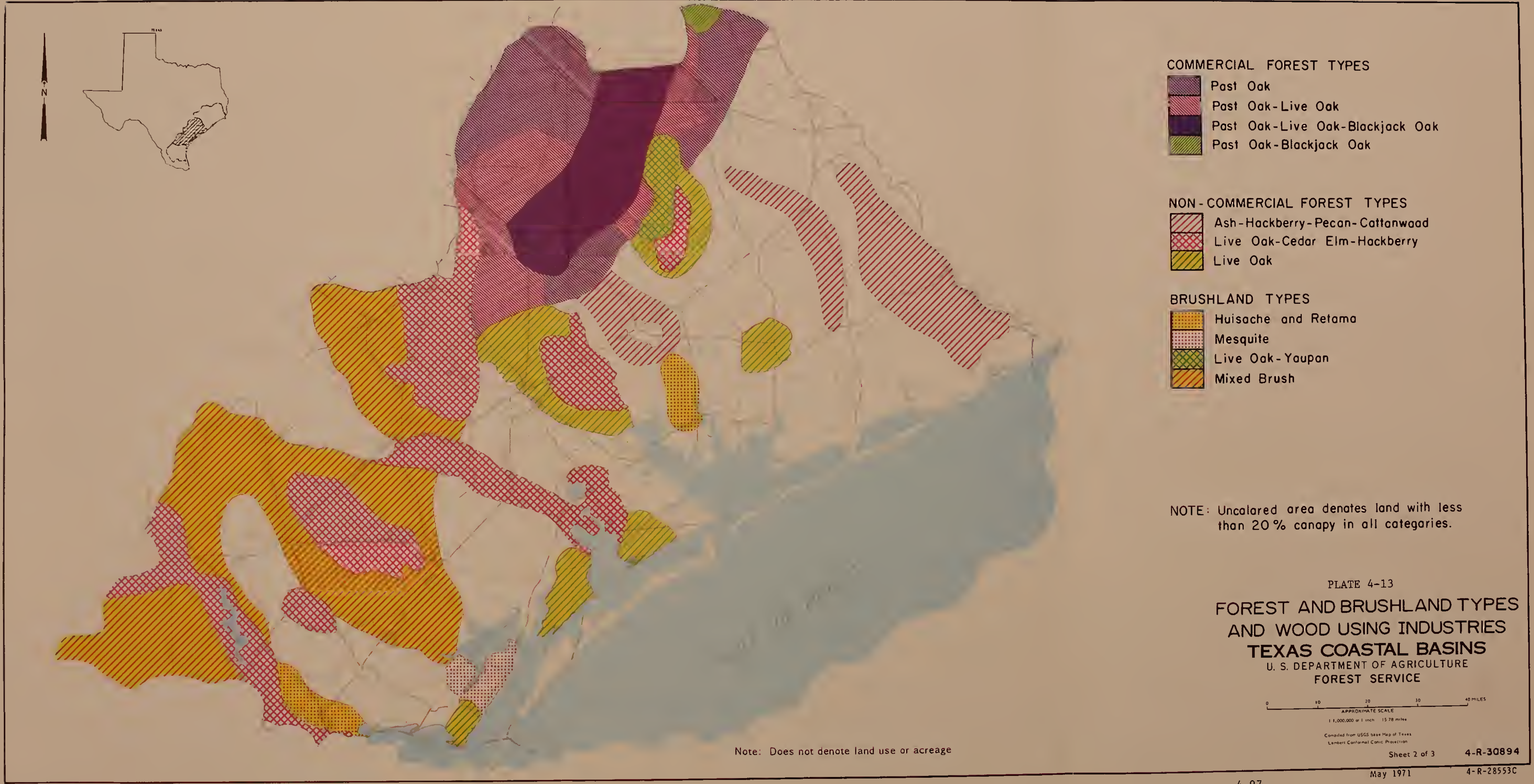
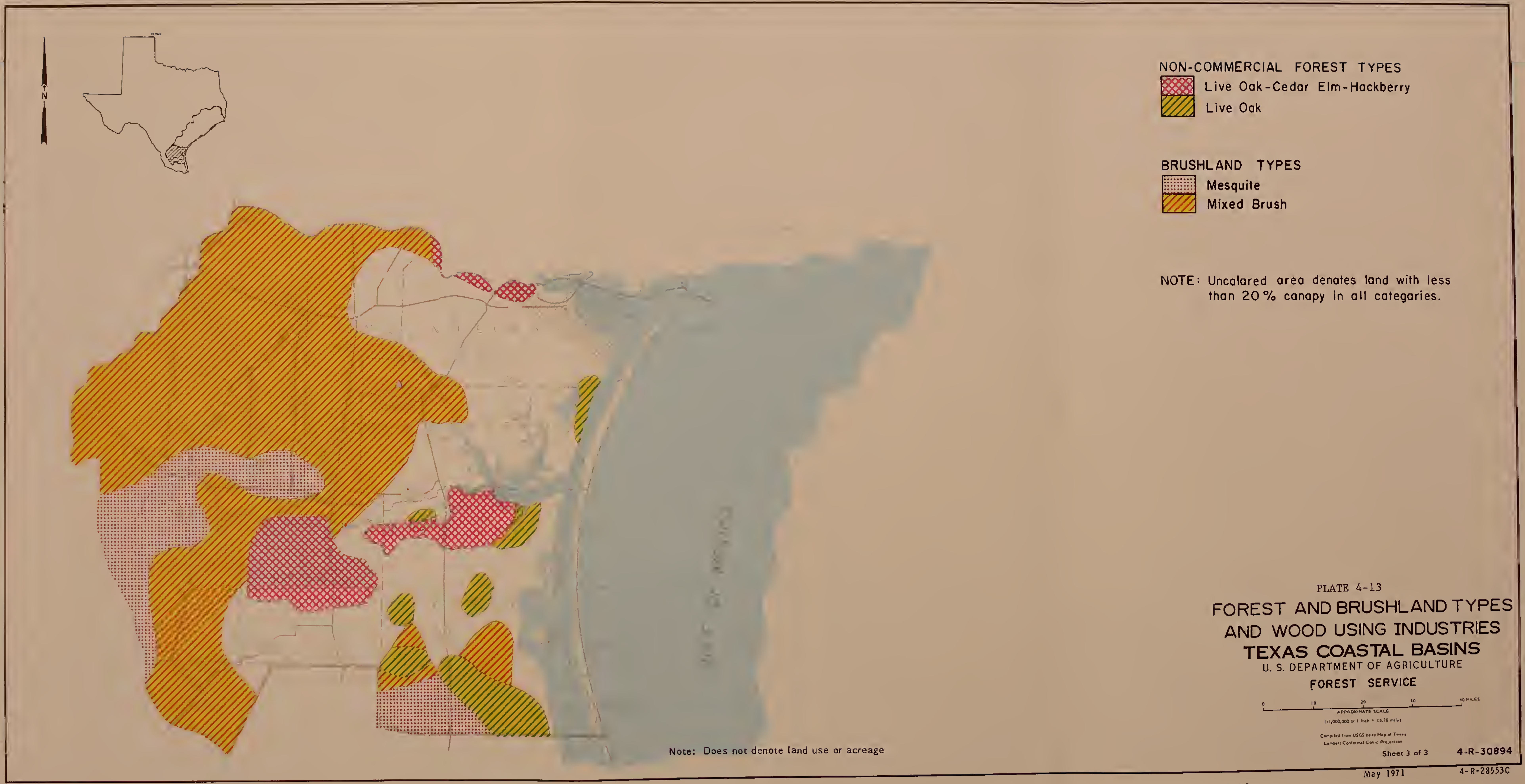


PLATE 4-13

FOREST AND BRUSHLAND TYPES AND WOOD USING INDUSTRIES TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

May 1971 4-R-28553C



May 1971

4-R-28553C

USDA-SCS-FORT WORTH, TEX. 1971

TABLE 4-5

Inventory of Parks and Parklands

Texas Coastal Basins

Administrating Entity	Basin		
	Parks No.	Developed Acres	Total Acres
Federal	8	2774	127007
State	19	4714	29590
County	76	3182	6985
Municipal	798	13094	15456
Private	182	4170	10616
TOTAL	1083	27934	189654

Source: Information compiled by River Basin Staff from data taken from Texas Outdoor Recreation Plan

TABLE 4-6

Outdoor Recreation

Texas Coastal Basins

Recreational Activities	Facilities		Total Activity Days (1000)
	Unit	Total	
Camping	Camps	3070	1658
Picnicking	Tables	5800	7472
Swimming	1000 Sq. Yds.	131	8588
Golf	Holes	559	1807
Child's Play	Acres	900	23431
Baseball/Softball	Fields	460	7226
Trails	Miles	215	2041
Watersports	Suitable Surface Acres	120500	20193

Source: Information compiled by River Basin Staff from data taken from Texas Outdoor Recreation Plan.

TABLE 4-7

Major Recreational Areas and Tourist Attractions

Texas Coastal Basins

AREAS OR ATTRACTIONS	SIZE	PURPOSE
1. Big Thicket Biological Preserve	84,550 acres	Natural Areas
2. Alabama-Coushatta Indian Reservation	1,280 acres	Only Indian reservation in Texas
3. Sam Houston National Forest	158,232 acres	National forest with recreational developments adjoining Lake Stubblefield and Double Lake
4. Lake Conroe	20,985 surface acres	Water-oriented recreation
5. Lake Houston	12,240 surface acres	Water-oriented recreation
6. Harris County Dome Stadium (Astrodome)	--	World's first air-conditioned stadium for baseball and football
7. Lyndon B. Johnson Space Center (NASA)	--	Manned space craft center
8. Galveston Island	32 miles	Beaches lying along the Gulf Coast
9. Gulf Coast	300 miles	Salt water associated recreational activities
10. Stephen F. Austin State Park	664 acres	Offers outdoor recreation experience, such as camping
11. Goliad State Park	208 acres	Offers outdoor recreation experience, such as camping
12. Goose Island State Park	307 acres	Salt water associated recreational activities
13. Lake Corpus Christi	14,187 surface acres	Fresh water oriented recreation
14. Padre Island National Seashore	133,918 acres	Salt water associated recreational activities
15. King Ranch	823,000 acres	Largest privately-owned ranch in Continental United States

Source: Information compiled by River Basin Staff from Texas Outdoor Recreation Plan 1975 and Texas Highway Department publication "Texas - Land of Contrast".

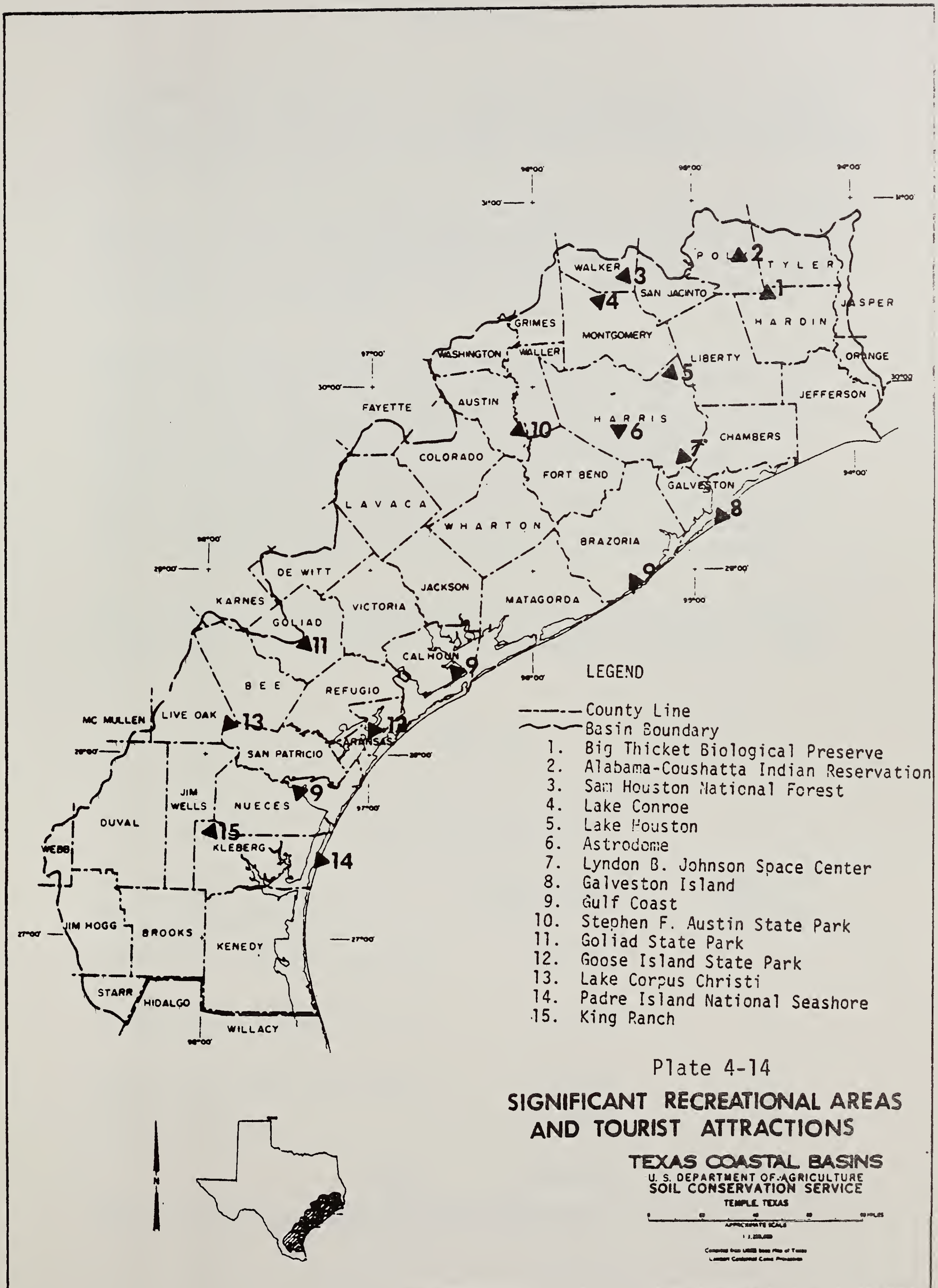


Plate 4-14

SIGNIFICANT RECREATIONAL AREAS AND TOURIST ATTRACTIONS

Generally, sufficient water is available from surface or ground sources in the study area. The amount of freshwater available decreases from the east to the west, corresponding with decreasing average annual rainfall.

Average annual surface water runoff within the study area ranges from about 1,260 acre-feet (about 24 inches) per square mile in the Neches-Trinity Coastal Basin to less than 8 acre-feet (about 0.2 inch) per square mile in the southern portion of the Nueces-Rio Grande Coastal Basin.

Although a limited supply of surface water is available for use in the intervening areas along the coast, the major source of surface water is the seven major rivers that originate outside the study area. Several additional rivers and major streams originate within the study area. It is estimated that an average of 30 million acre-feet of water reaches the Gulf of Mexico annually from surface sources. About 62 percent of this water originates on watersheds above the study area boundary and is carried through the area by the seven major streams.

Water resource impoundments, either existing or under construction, account for 1,056,700 acre-feet of surface water storage in the basin. The breakdown of impoundments is shown in Table 4-8.

TABLE 4-8

Storage Capacity of Impoundments

Texas Coastal Basins

Type of Impoundments	Storage Capacity (Ac-Ft)	Number of Reservoirs
Reservoirs >100,000 acre-feet	874,800	3
Reservoirs between 1,000 and 100,000 acre-feet	117,100	52
Reservoirs <1,000 acre-feet	62,100	267
SCS WS Projects	2,700	18
Total	1,056,700	340

Source: Compiled by River Basin Staff, SCS

The aquifers which occur partially or wholly within the study area are shown on Plate 4-15. The Alluvial Aquifer is considered to be a major aquifer. The Upper and Lower units of the Chicot and Evangeline Aquifer are collectively designated as the Gulf Coast Aquifer. The other waterbearing units are not considered either as major or minor aquifers since they do not furnish large quantities of water. Within the basin they do furnish rural, domestic, and livestock water, and are, therefore, considered as aquifers.

Plate 4-16 shows the average static water level below ground surface throughout the basin. It is estimated that the Gulf Coast Aquifer, which lies almost entirely within the study area, has an annual yield of 1,143,400 acre-feet. Estimated annual yields in several of the river basins which are entirely within the study area are shown below.

Basin	Estimated Annual Yield, Ac-Ft
Neches - Trinity	14,000
Trinity - San Jacinto	36,000
San Jacinto River	295,000
San Jacinto - Brazos	82,000
Brazos - Colorado	68,000
Colorado - Lavaca	8,000
Lavaca River	86,000
Lavaca - Guadalupe	48,000
San Antonio - Nueces	30,000
Nueces - Rio Grande	115,000

The above basins represent 62.6 percent of the study area and on this basis the estimated annual yield from all aquifers for the entire study area is 1,248,000 acre-feet.

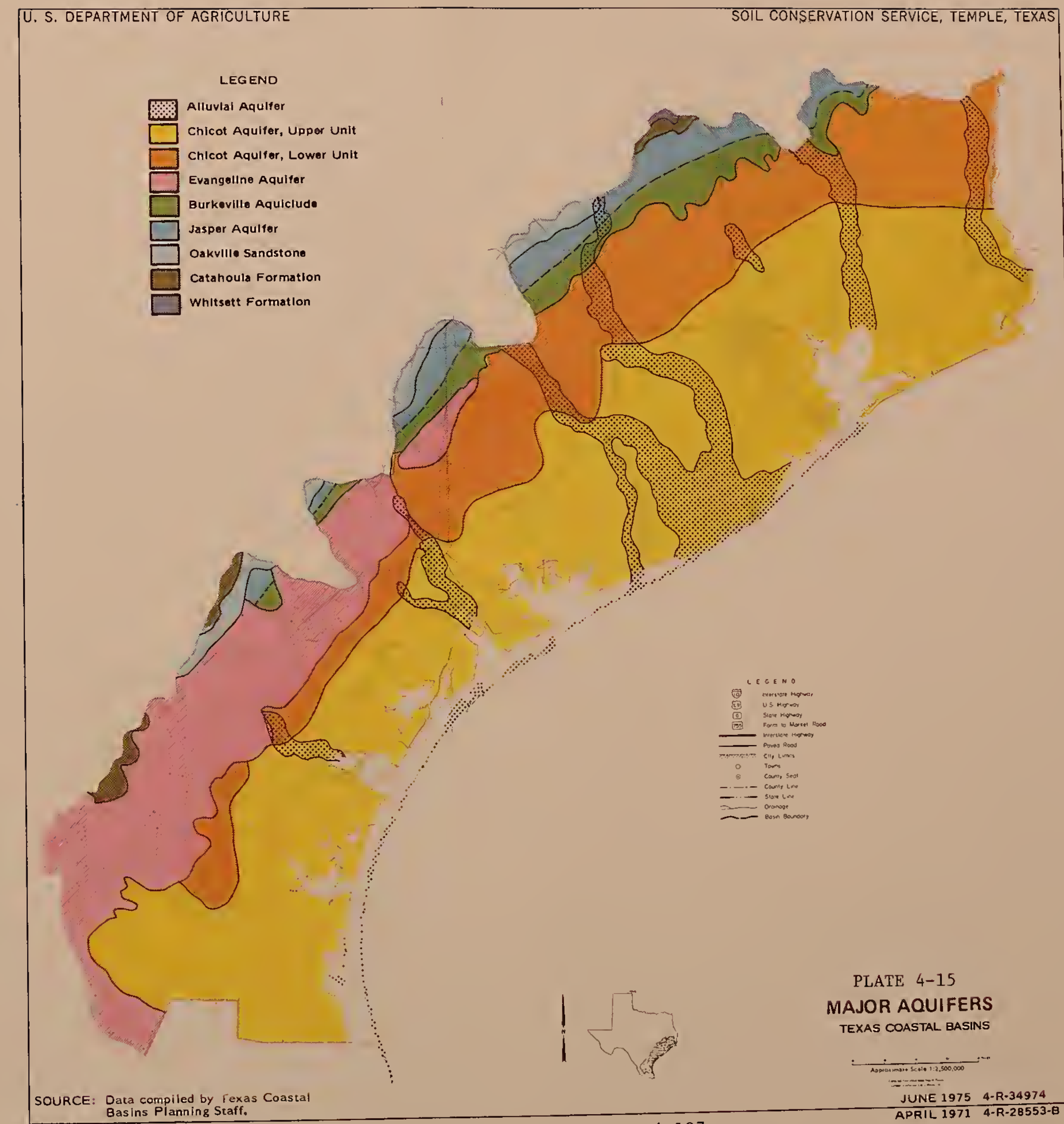
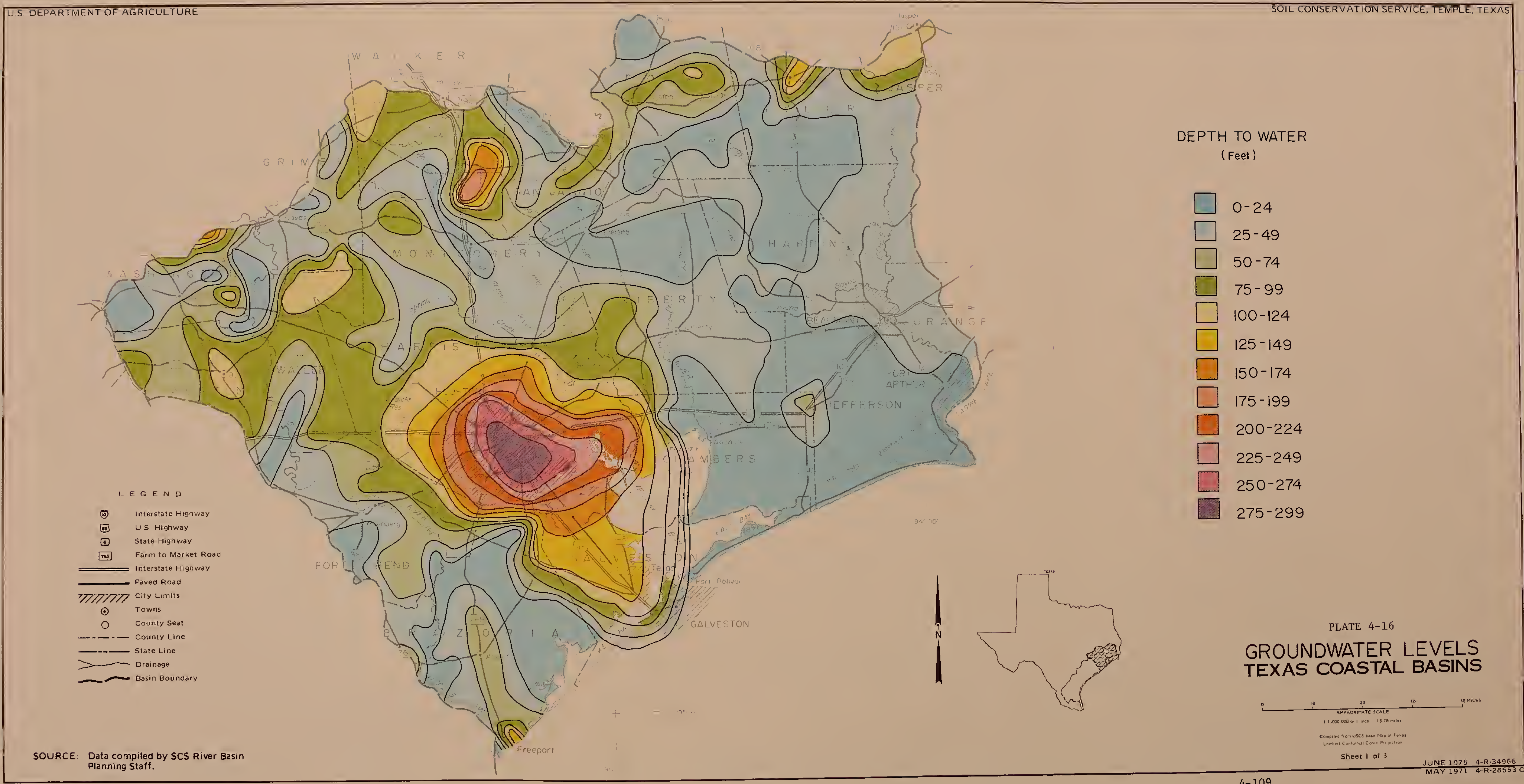
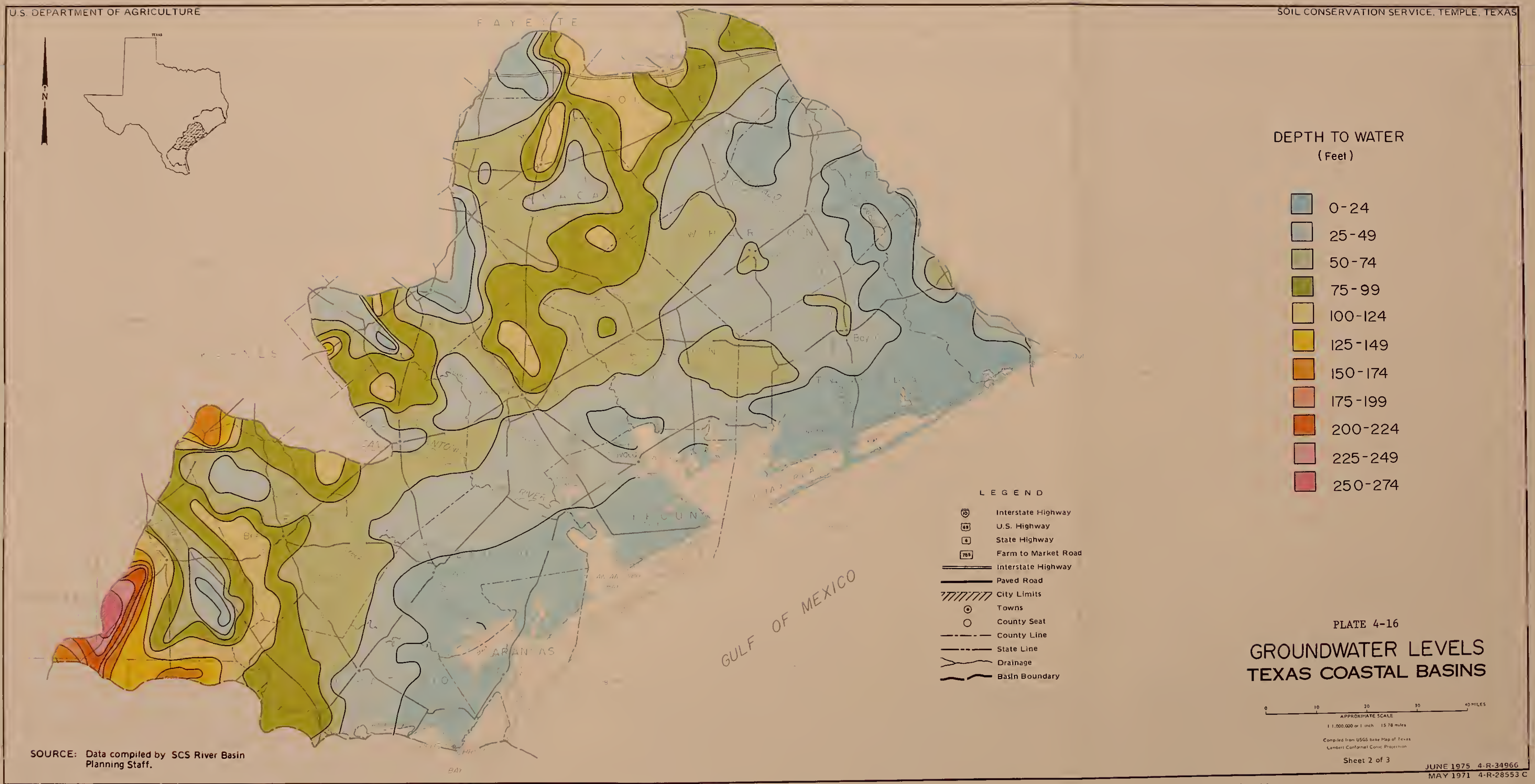


PLATE 4-15
MAJOR AQUIFERS
TEXAS COASTAL BASINS



USDA-SCS-FORT WORTH, TEX. 1976



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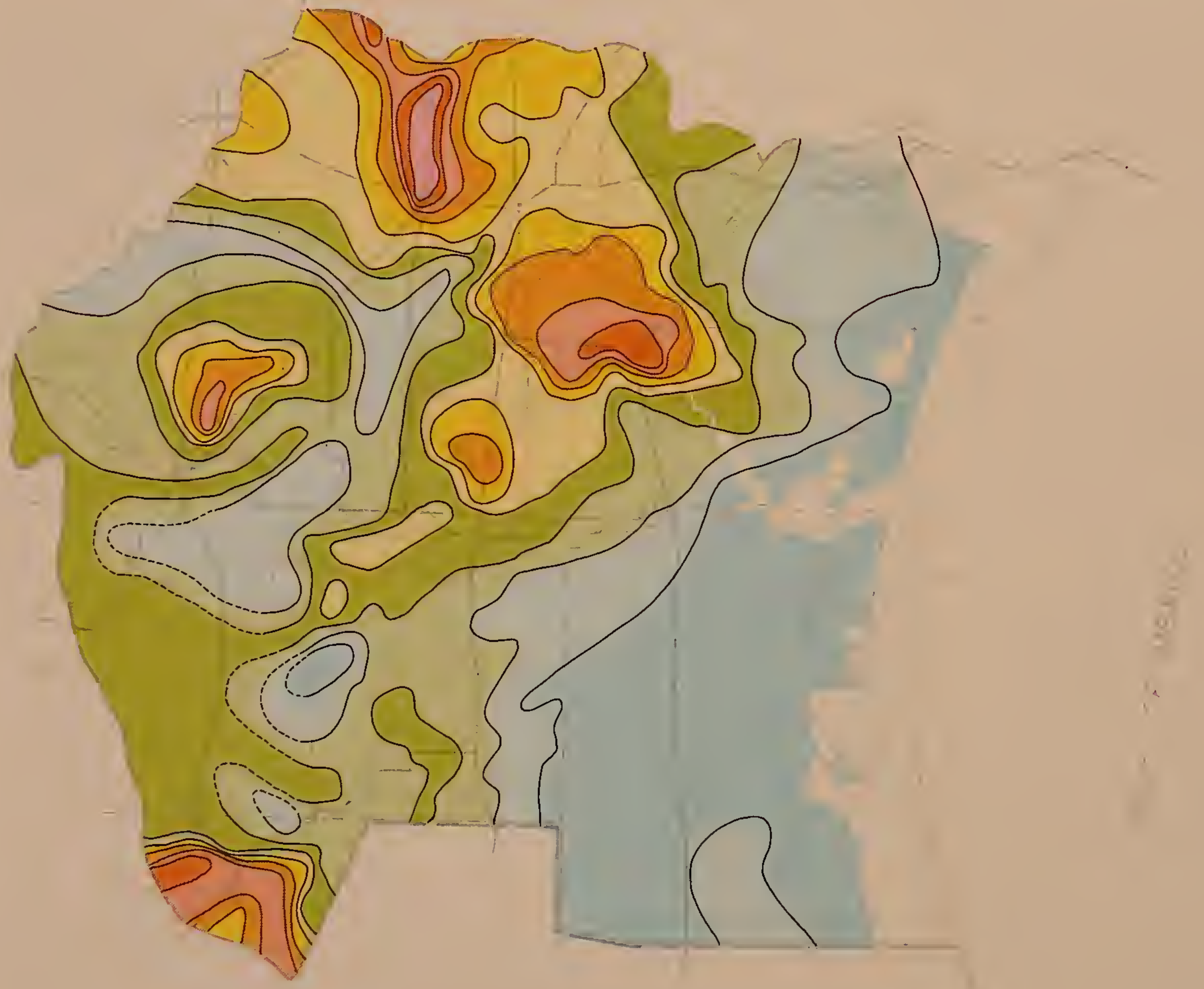
U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, TEMPLE, TEXAS



DEPTH TO WATER
(Feet)

- 0-24
- 25-49
- 50-74
- 75-99
- 100-124
- 125-149
- 150-174
- 175-199
- 200-224
- 225-249

APPROXIMATE LINE

LEGEND

- Interstate Highway
- U.S. Highway
- State Highway
- Farm to Market Road
- Interstate Highway
- Paved Road
- City Limits
- Towns
- County Seat
- County Line
- State Line
- Drainage
- Basin Boundary

PLATE 4-16

GROUNDWATER LEVELS
TEXAS COASTAL BASINS

0 10 20 30 40 MILES
APPROXIMATE SCALE
1:1,000,000 or 1 inch = 15.78 miles

Compiled from USGS base Map of Texas
Lambert Conformal Conic Projection

Sheet 3 of 3

JUNE 1975 4-R-34966
MAY 1971 4-R-28553 C

SOURCE: Data compiled by SCS River Basin Planning Staff.

USDA-SCS-FORT WORTH, TEX. 1976

CHAPTER 5

ECONOMIC DEVELOPMENT AND PROJECTIONS

TEXAS COASTAL BASINS

CHAPTER 5

ECONOMIC DEVELOPMENT AND PROJECTIONS

INTRODUCTION

This chapter describes the socio-economic base of the Texas Coastal Basins and desired future conditions. Information is presented about the historical social and economic development, the current base which has developed in the Texas Coastal Basins, and projections of economic activity accompanied by expressions of significant measures desired concerning production, resource use, and conservation. It provides parameters for the projection of economic data on one hand and measures of desired resource conditions on the other. Data concerning water shortages and outdoor recreation reflect the State's view of progressive development. Agricultural production projections, based on U. S. Water Resource Council Projections, which represent the national viewpoint, approximate or exceed the State's production desires as expressed in their 1968 report. Projected resource use is based on this level of production.

This information provides a basis for and quantification of product or condition requirements. These data, compared to the analyses of conditions without accelerated development in Chapter 6 establish quantified needs for development as presented in Chapter 7.

HISTORICAL DEVELOPMENT

The study area has been the scene of a large share of the State's significant historical events.

The early Spanish explorers such as Cabeza de Vaca and Vásquez de Coronado were the first white men to visit the area. The first settlement was established by Robert Cavelier, Sieur de la Salle, a Frenchman, who established Fort St. Louis on Matagorda Bay in the mid 1680's. Due to crop failure, harassment by the Karankawa Indians, and finally the assassination of La Salle by one of his own men, the fort was soon destroyed. When the Spanish found out about the existence of La Salle's fort, they realized they would never be secure in the area until they took possession of it. Therefore, they decided to send priests with military escorts into the area to establish missions. This effort was also doomed to failure due to crop failure, epidemics, and unfriendly Indians. By 1710 the French were again threatening to settle the area, so by 1716 the Spanish had established six missions to meet this threat. From 1716 until about 1820 the Spanish laid claim in one form or another to the area now included in the study area and made ambitious and repeated attempts to colonize it, most of which were unsuccessful. After 100 years of this effort about the only permanent Spanish settlement in the area was La Bahia (Goliad) which was the location of the Mission La Bahia del Espiritu Santa de Zuiniga and Presidio Nuestra Señora de Loreto. The mission has been restored to its original state and is a significant tourist attraction and historical site. The first Anglo-American settlement in the study area was established on the Brazos River in 1821 and was called Washington-on-the-Brazos. It was in this year that Mexico achieved independence from Spain. Stephen F. Austin received a colonization grant from the new government in Mexico City in 1823. By 1830 the Mexican government began to realize that a very real threat to its sovereignty in the area existed, if the extensive Anglo-American colonization were allowed to continue, and on April 6, 1830, they issued a decree which forbid further Anglo-American immigration. By 1835 the colonists had begun a revolution which ended in April of 1836 with the defeat of the Mexican army at San Jacinto and the establishment of Texas as an independent republic. Several significant events in the Texas Revolution took place within the study area. On March 19, 1836, James W. Fannin, Jr., and about 450 of his men were surrounded by superior Mexican forces and the next day they surrendered. A week later, on Palm Sunday, Fannin and his remaining 350 men were executed near the La Bahia mission at Goliad. A historical monument and park marks this spot. The Battle of San Jacinto, in which Texas won its independence by the defeat of Santa Anna's army by Sam Houston was fought near where Buffalo Bayou and the San Jacinto River join in Harris County. A tall stone monument overlooks this battleground today.

Several of the early government headquarters were located in the study area. The first Anglo-American capital of Texas was San Felipe de Austin. The provisional government of Texas met at Washington-on-the-Brazos on March 1, 1836. In this convention all powers of sovereignty were claimed and exercised, a Declaration of Independence was adopted, a constitution was written, and executive officers were inaugurated. Because of the movement of Santa Anna's troops, President Burnet, for convenience, selected Harrisburg on Buffalo Bayou as the temporary capital.

At the approach of Santa Anna, President Burnet, with a part of his cabinet, took refuge on Galveston Island. After the battle of San Jacinto, the Treaty of Velasco was signed at Velasco in Brazoria County, the temporary seat of government. In October 1836, the first permanent government of the Republic of Texas went into operation at Columbia. also in Brazoria County. In 1836 President Houston ordered the capital moved to Houston in Harris County, where it remained until moved to Austin in 1840. Almost all the military activity in Texas directly relating to the Civil War occurred within the study area. Galveston was blockaded in 1861 by a Federal force and the Confederate troops evacuated the island. John B. Magruder recaptured the island in 1863. At the Battle of Sabine Pass, the small group of Texas defenders turned back a sizeable naval force; however, the Federal troops occupied Brownsville, Corpus Christi, Aransas Pass, Indianola, and others.

After the war the area saw rapid growth of railroads, industrialization, and agriculture. The first meat packing plant was established at Victoria in 1868. Oil became important to the area as did the development of other mineral resources. In 1901 the Spindletop well near Beaumont blew in as the State's first great gusher, though not its first oil discovery. Spindletop was the forerunner of many large oil fields and of the huge refining and associated industry development that was to mushroom along the coast during the next 70 years.

As can be seen by the above discussion, many of the major historical events and places in Texas are located in the Texas Coastal Basins study area. Many of these events and places have been designated as historically significant points of interest by the Texas State Historical Survey Committee in a continuing effort to locate and preserve these areas. Galveston County has the largest number of such sites. Many of these sites are buildings of architectural importance such as the Galveston County Courthouse and St. Mary's Cathedral. Others include West Galveston Island, which provided sanctuary for the famous pirate Jean Laffite and a camp site for the cannibalistic Karankawa Indians.

Harris County contains the second largest number of historically important sites. Some of the most famous of these include the San Jacinto Monument and Battleground, the Battleship Texas, Old Market Square, Lynch's Ferry, and the original Port of Houston. Modern culturally significant sites include the Astrodome, the Astroworld, and the National Aeronautics and Space Administrations's manned spacecraft center. The Houston ship channel is of historical significance because the access opened the area to world trade.

Scattered throughout the rest of the study area are: cemeteries with historical importance; the site of the first sulphur mine in Texas; the first railroad in the State; sites of the famous battle of the Texas Revolution such as the Goliad Massacre; and many others.

HUMAN RESOURCES AND THE ECONOMY

Population

People constitute the market for goods and services, provide labor for industrial growth, and are the spawners of ideas and initiatives that create opportunity for more people. People are the basis of social service needs as well as one of the principal factors determining the need for development of water and land resources. Before transportation systems became more sophisticated, population concentrations were significantly located near or on the most productive agricultural soils and surface water sources. Over time, the requirement for these productive resources has remained, but the necessity for location in the immediate vicinity has lessened. Nevertheless, population characteristics of an area relate important information about both existing social needs and perspectives on economic development. Natural resource development is an integral, even basic, part of economic development.

Population of the Texas Coastal Basins, as a whole, has been characterized by growth faster than the State or national rate, Table 5-1. This characteristic is not consistent throughout the basin as indicated by increasing population but decreasing shares in the Middle and Lower Subareas. The Upper Subarea has increased its share of basin population from 68 percent in 1950 to 75 percent in 1970. Consistent with trends of the recent past, rural areas do not make up the basic pattern of this growth. More specifically, growth has occurred about existing population centers. Three standard metropolitan statistical areas (SMSAs), Houston, Galveston-Texas City, and Beaumont-Port Arthur-Orange are in the Upper Subarea, and one, Corpus Christi in the Lower. The Middle Subarea is loosely surrounded by half a dozen SMSAs but does not include any, as shown in Figure 5-1. In 1950, the Texas Coastal Basins contained 24.8 percent of the State's population and about 1.3 percent of national population. By 1970, the basin had grown to about 28.7 percent of the State's population and about 1.6 percent of the United States population. Projections reflect substantially lower estimates in all parts of the basin than those published by the Texas Water Development Board (TWDB). By 2020, the Texas Water Development Board's population projections are 42 percent higher than OBERS E, which reflects expectations of less population growth nationwide due principally to a lower birth rate. However, the OBERS E projections also reflect a positive but long-term declining rate of growth for the basin in relation to the rest of the Nation, Table 5-2. The accuracy of this trend may be fortified by knowledge of the many social problems being experienced by the Nation's major growth centers but such factors are counter balanced by the vast spatial and trade access as well as basic natural resource advantages for continued growth.

TABLE 5-1

Basin and Subarea Populations - 1950, 1960, 1970

Texas Coastal Basins

SUBAREA	1950	1960	1970
Upper	1,291,000	1,833,100	2,423,900
Percent of TCB	68.1	71.3	75.4
Middle	314,600	338,600	370,000
Percent of TCB	16.6	13.1	11.5
Lower	322,400	402,000	420,000
Percent of TCB	15.3	15.6	13.1
Basin	1,928,000	2,573,700	3,213,900
Percent of State	24.8	26.9	28.7
Percent of Nation	1.3	1.4	1.6

Sources: Texas Water Development Board, Population Projections, December 1972. U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3.

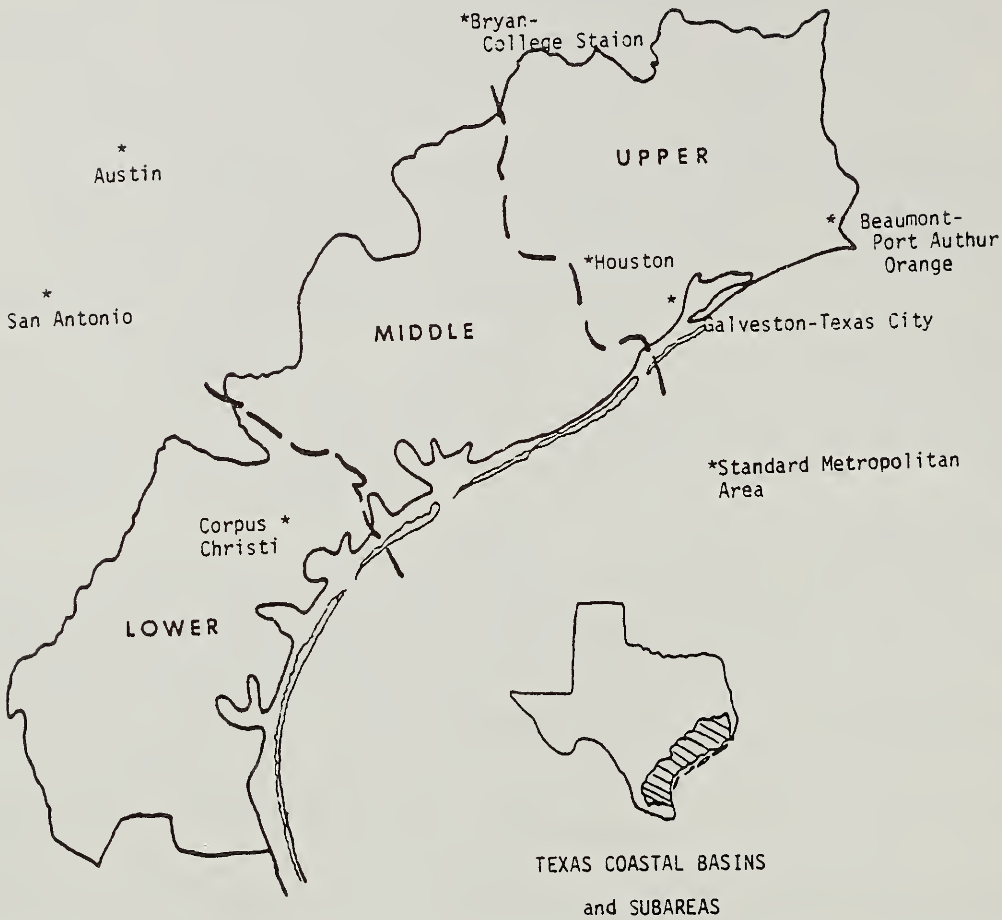
The TWDB's projections are much more optimistic, as shown in Table 5-2. These projections express increased shares of both State and national total population through 2020. Projected growth throughout the basin is greater than that expressed in OBERS E, but the focal point is in the Upper Subarea which is projected to be three million persons larger. While the Middle and Lower Subareas' growth is expected to be about 12 percent per decade, the Upper, growing from an already larger base, is projected to grow more than 50 percent per decade.

Because extensive supportive work has been done on State population data within the State and detailed projection data are available to

FIGURE 5-1

Locations of Standard Metropolitan Statistical Areas in and about the Basin

Texas Coastal Basins



Source: ERS

the county level, population projections of the sponsoring State agency were used in computations upon which resource requirements are dependent.

Texas is composed of a large number of ethnic groups which in reality are minority groups. The State and basin have been influenced by the settlement of German, Czech, Italian, Spanish, Indian, Negro, and French, and all have had an influence on the character of the area. Some communities trace their particular aura to lingering ancestral influence.

Rural-urban composition of the Texas Coastal Basins's population is shown by county within subareas in Table 5-3. This table reveals that the poverty level of the various counties within the Texas Coastal Basins is fairly closely related to that county's percentage of Negro and Spanish surname populance. The range of

TABLE 5-2

Projected Population, Area Relationships, and
Source Comparisons, 1970, 2000, and 2020

Texas Coastal Basins

SUBAREA	SOURCE	1970	2000	2020
Upper	OBERS E	2,423,900	3,435,800	3,914,700
	TWDB	2,423,900	4,553,500	6,924,800
Middle	OBERS E	370,000	464,600	509,100
	TWDB	370,000	573,700	858,000
Lower	OBERS E	420,000	435,500	453,800
	TWDB	420,000	588,800	738,900
Basin	OBERS E	3,213,900	4,335,900	4,877,600
	TWDB	3,213.900	5,716,000	8,521,700
State	OBERS E	11,196,700	14,632,600	16,607,200
	TWDB	11,196,700	18,146,100	25,029,200
TCB, Percent of State	OBERS E	28.7	29.6	29.4
	TWDB	28.7	31.5	34.0
Nation	OBERS E	203,857,900	263,830,000	297,146,000
TCB, Percent of Nation	OBERS E	1.6	1.6	1.6
	TWDB	1.6	2.2	2.9

Sources: Texas Water Development Board, Population Projections, December 1972. U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3.

county composition for these particular measures are rather dramatic within each subarea. Other than variation in total population from county to county, probably the most noticeable trait is the variance of Negro and Spanish surname people. From the Upper to the Lower Subarea the proportion of the Negro inhabitants decreases while the proportion of Spanish surname increases. In the Lower Subarea, the presence of Negroes ranges from 0 to 4.7 percent while Spanish surnamed is 46.3 to 100 percent. Poverty level family income tends to be a greater problem in the Lower Subarea of the Texas Coastal Basins.

TABLE 5-3

Selected County Population Characteristics by Subarea, 1970

Texas Coastal Basins

Subarea County 1/	Population	Rural	Urban	Negro	Spanish Surname	Poverty Level 2/
		--------	---Percent--	--------	--------	--------
UPPER						
Brazoria	108,312	38.7	61.3	9.9	8.9	10.2
Chambers	12,187	100.0	0.0	20.4	1.3	21.8
Fort Bend	52,314	44.4	65.6	16.9	32.9	21.3
Galveston	169,812	10.6	89.4	19.6	9.8	14.0
Grimes	11,855	56.9	24.1	35.2	7.3	41.4
Hardin	29,996	74.3	25.7	15.2	0.6	18.7
Harris	1,741,912	4.5	95.5	20.2	10.3	12.2
Jasper	24,692	74.7	25.3	23.2	0.1	25.0
Jefferson	244,773	5.1	94.9	24.9	2.7	15.4
Liberty	33,014	54.5	45.5	21.1	0.4	22.6
Montgomery	49,479	75.8	24.2	12.4	1.1	17.4
Orange	71,170	33.8	66.2	9.2	1.4	12.3
Polk	14,457	72.9	27.1	27.1	1.0	32.4
San Jacinto	6,702	100.0	0.0	41.9	0.0	39.9
Tyler	12,417	78.6	21.4	18.0	0.1	24.8
Walker	27,680	36.4	63.6	28.4	1.3	31.3
Waller	14,285	72.6	27.4	52.5	5.6	29.5
Characteristic Range	6,702-1,741,912	4.5-100.0	0.0-95.5	9.2-52.5	0.1-32.9	10.2 41.4

TABLE 5-3 (Cont'd)

Selected County Population Characteristics by Subarea, 1970

Texas Coastal Basins

Subarea 1/ County	Population	Rural	Urban	Negro	Spanish Surname	Poverty Level 2/
		---Percent---				
MIDDLE						
Aransas	8,902	48.3	51.7	4.6	33.9	21.3
Austin	13,831	80.6	19.4	19.6	0.0	30.6
Bee	22,737	40.6	59.4	2.7	53.4	29.3
Brazoria	108,312	38.7	61.3	9.9	8.9	10.2
Calhoun	17,831	41.2	58.8	4.7	37.5	20.3
Colorado	17,638	60.7	39.3	23.2	14.0	22.4
DeWitt	18,660	49.6	50.4	12.5	27.3	29.9
Fort Bend	52,314	44.4	65.6	16.9	32.9	21.3
Goliad	4,869	100.0	0.0	12.0	49.3	37.0
Gonzales	16,375	64.3	35.7	15.8	36.4	36.0
Grimes	11,855	56.9	43.1	35.2	7.3	41.4
Jackson	12,975	58.9	41.1	12.2	21.7	26.2
Matagorda	27,913	44.9	55.1	19.4	22.1	24.4
Refugio	9,494	54.3	45.7	9.8	43.6	25.5
Victoria	53,766	23.1	76.9	8.0	35.4	21.8
Waller	14,285	72.6	27.4	52.5	5.6	29.5
Washington	18,842	52.6	47.4	27.9	1.0	31.8
Characteristic Range	4,869-108,312	23.1-100.0	0.0-76.9	2.7-52.5	0.0-53.4	10.2 41.4

TABLE 5-3 (Cont'd)

Selected County Population Characteristics by Subarea, 1970

Texas Coastal Basins

Subarea County 1/	Population	Rural	Urban	Negro	Spanish Surname	Poverty Level 2/
		---------	---Percent---	---------	---------	---------
LOWER						
Brooks	8,005	20.6	79.4	1.3	82.9	44.7
Duval	11,722	44.0	56.0	0.2	87.5	49.0
Jim Wells	33,033	26.9	73.1	1.2	66.6	31.5
Jim Hogg	4,654	12.4	87.6	1.0	87.9	49.8
Karnes	13,462	47.4	52.6	3.3	46.3	39.4
Kenedy	678	100.0	0.0	0.0	100.0	43.9
Kleberg	33,166	13.4	86.6	4.4	54.6	29.4
Live Oak	6,697	100.0	0.0	1.4	48.0	32.7
McMullen	1,095	100.0	0.0	0.6	54.5	30.7
Nueces	237,494	6.0	94.0	4.7	50.7	21.5
San Patricio	47,288	35.8	64.2	2.4	54.1	32.6
Webb	72,859	3.7	96.3	1.7	86.2	44.7
Characteristic Range	678-237,494	3.7-100.0	0.0-96.3	0.0-4.7	46.3-100.00	21.5-49.8

1/ Counties may be partially in the Texas Coastal Basins and/or divided between subareas of the basin, but shown as whole counties.

2/ Poverty Definition Guidelines furnished by Social Security Administration.

Persons/Family	Non-Farm Family	Farm Family
1	$2,100	$1,800
2	2,725	2,325
3	3,450	2.950
4	4,200	3,570
5	4,925	4,200
6	5,550	4,725
7	6,200	5,275
Other	+650	+550

Sources: U. S. Department of Agriculture, Selected Historical, Social and Demographic Information, May 1974 and ERS.

Employment

Employment of human resources in the Texas Coastal Basins has increased from 0.7 million in 1950 to 1.2 million in 1970. Almost 80 percent of the 1970 basin employment is in the Upper Subarea, Table 5-4.

One measure which adds some perspective to a population is the rate of employment participation. The U. S. and Texas rates have been quite close in recent decades. There is more variation apparent in smaller areas, and particularly between metropolitan and non-metropolitan areas than between the basin and ation.

TABLE 5-4

Historical and Projected Employment and Participation by Subarea

Texas Coastal Basins

Area	Unit	1950	1960	1970	2000	2020
Upper						
Employment	No.	490,600	678,200	945,300	2,029,500	3,026,800
Participation	%	38	37	39	45	44
SMSA		00	00	39	45	45
NON-SMSA		00	00	33	41	40
Middle						
Employment	No.	113,300	125,300	144,300	252,200	377,500
Participation	%	36	37	39	44	44
SMSA		00	00	*	*	*
NON-SMSA		00	00	39	44	44
Lower						
Employment	No.	106,400	128,700	142,800	235,500	302,900
Particiaption	%	33	32	34	40	41
SMSA		00	00	36	41	42
NON-SMSA		00	00	32	38	39
Basin						
Employment	No.	710,200	932,200	1,232,400	2,517,200	3,707,300
Participation	%	37	37	39	44	44
SMSA		00	00	39	44	44
NON-SMSA		00	00	35	41	41
State Average	%	37	37	39	44	44
U. S. Average	%	38	37	39	45	44

Source: Texas Industrial Commission, Texas Regional Market Projections, 1950-1990, August 1973.

U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3.

The non-metropolitan areas in the Upper and Lower Subareas have lower employment participation rates than metropolitan areas. However, the non-metropolitan rate in the Middle Subarea, where no SMSAs are located, is equal to or greater than metropolitan rates in the other subareas. OBERS E employment participation rate projections have been applied to TWDB population projections to estimate the scale of employment for the basin and its parts. Participation rates at all levels are expected to increase through 2020. Non-metropolitan rates are expected to equal or surpass the 1970 national average. Participation rates in the Lower Subarea continue to increase but remain lower than rates of the Upper and Middle Subareas. Basin employment at 44 percent participation is projected to be about 3.7 million with more than 80 percent found in the Upper Subarea.

Additional perspectives concerning industrial sector scale of employment may be drawn from industrial sector shares of earnings in major employment areas, which follows.

Personal Income

Personal income measures directly the size of the consumer market and indirectly the industrial market. It provides an estimate, across wide aggregation, of area economic health and the economic welfare of its residents. This array of income data furnishes a statistical frame work which may explain the way in which an area economy functions. One important component of personal income is the aggregate "earnings of persons", or "earnings". This is the sums of wages, salaries, other labor income, and proprietors' incomes before taxes but after social service deductions in each industry. Earnings in all U. S. industries combines account for about 80 percent of the total personal income.

Table 5-5 shows that the portion constituting earnings is fairly uniform both at the U. S. level and between subareas of this basin. However, the earnings portion is tending to decrease, giving way to the other constituents of personal income, i.e., property income, and transfer payments for which no current services have been derived, Table 5-6. This portion of total personal income is increasing at a faster rate than the earnings portion. Basin total personal income of $10.6 billion in 1970 is projected to be $107.2 billion in 2020. More than 80 percent of this value is based in the Upper Subarea.

The array of industries through which this wealth flows is shown in Table 5-7 for each SMSA. For each of the selected historical years and OBERS E projected years, the percent of total personal income emanating from the major itemized industry is shown.

TABLE 5-5

Portions of Total Personal Income Constituting
Earnings of Persons in Subareas, Historically and Projected

Texas Coastal Basins

Subarea	1950	1960	1970	2000	2020
	Percent				
UPPER	83	83	82	79	78
MIDDLE	82	80	77	75	75
LOWER	82	82	79	77	77
U. S.	82	81	79	77	76

Source: U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3.

TABLE 5-6

Total Personal Income

Texas Coastal Basins

Subarea Category	1950	1960	1970	2000	2020
	1967 $000				
Upper					
Total Income	2,819,500	4,432,400	8,406,100	36,232,200	89,032,200
Earnings	2,340,200	3,678,900	6,893,000	28,623,400	69,445,100
Property Earnings & Transfers	479,300	753,500	1,503,100	7,608,800	19,587,100
Middle					
Total	502,500	632,200	1,060,100	3,897,800	9,781,200
Earnings	412,100	516,500	837,500	3,001,300	7,483,600
Property Earnings & Transfers	90,400	115,700	222,600	896,500	2,297,600
Lower					
Total Income	511,300	738,100	1,125,900	3,886,100	8,349,600
Earnings	419,300	590,500	866,900	2,920,400	6,262,200
Property Earnings & Transfers	92,000	137,600	259,000	965,700	2,087,400
Basin					
Total Income	3,833,200	5,806,400	10,592,100	44,016,000	107,162,900
Earnings	3,171,400	4,785,900	8,597,400	34,545,100	83,190,800
Property Earnings & Transfers	661,800	1,020,500	1,994,700	9,470,900	23,972,100

Source: U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3.

TABLE 5-7

Earnings of Persons in Major Industries as a Share of Total Personal Income for Standard Metropolitan Areas, Historical and Projected

Texas Coastal Basins

SMSA Industry	1950	1960	1970	2000	2020
			Percent		
			Galveston - Texas City		
Personal Income	100.00	100.00	100.00	100.00	100.00
Agriculture	01.37	00.70	00.30	00.13	00.10
Mining	00.59	01.10	00.55	00.35	00.25
Contract Construction	04.78	05.77	06.99	05.31	04.39
Manufacturing	18.76	24.29	22.41	21.43	21.41
Wholesaling	13.17	10.42	08.64	05.25	04.19
Services	08.47	08.48	08.98	10.42	11.23
Government	08.97	12.84	14.00	17.67	19.92
Other	30.72	36.40	38.13	39.44	38.51
			Houston		
Personal Income	100.00	100.00	100.00	100.00	100.00
Agriculture	01.56	00.79	00.48	00.17	00.11
Mining	09.73	06.14	04.33	01.90	01.23
Contract Construction	08.32	06.86	08.56	06.06	05.41
Manufacturing	17.55	20.42	18.86	17.43	16.13
Wholesaling	18.22	16.86	16.84	14.54	13.38
Services	09.80	11.76	13.95	19.13	21.33
Government	05.89	08.33	08.71	09.64	10.22
Other	28.93	28.84	28.27	31.13	31.12

TABLE 5-7 (Cont'd)

Earnings of Persons in Major Industries as a Share of Total Personal Income for Standard Metropolitan Areas, Historical and Projected

Texas Coastal Basins

SMSA Industry	1950	1960	1970	2000	2020
	------	------	Percent	------	------
			Beaumont-Port Arthur-Orange		
Personal Income	100.00	100.00	100.00	100.00	100.00
Agriculture	01.71	01.45	00.41	00.16	00.11
Mining	02.43	03.03	01.52	00.24	00.15
Contract Construction	05.85	06.73	07.60	05.63	05.12
Manufacturing	33.80	38.07	37.22	33.07	30.10
Wholesaling	13.61	12.22	11.05	09.83	09.11
Services	09.26	09.15	10.36	15.12	17.14
Government	07.19	07.90	08.47	10.10	10.90
Other	26.15	21.45	23.37	30.92	27.37
			Corpus Christi		
Personal Income	100.00	100.00	100.00	100.00	100.00
Agriculture	08.39	06.06	02.92	01.33	00.97
Mining	07.37	07.73	04.22	01.47	00.95
Contract Construction	06.79	05.59	06.20	04.94	04.39
Manufacturing	08.30	13.40	12.06	11.30	10.31
Wholesaling	16.41	14.01	13.94	12.94	11.84
Services	08.60	09.91	10.96	14.79	16.77
Government	15.53	15.56	20.58	20.58	21.44
Other	28.61	27.74	29.12	32.65	33.33

Source: U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3.

Manufacturing and wholesaling activities are consistently leading earnings producers in each SMSA.

However, they are not the major industries which are projected to acquire larger shares of total personal income. Service industries, along with all levels of government and other industries (importantly including transportation and communications) are the fastest growing constituents. Not included in this array of industries is the remaining portion defined as property income and transfer payments for current services. This portion is growing at a faster rate than the earn~~ings of~~ industries.

Agricultural, mining, and contract construction in each of the SMSAs are important generators of "earnings for persons" which are increasing, but their share of total personal income is decreasing.

Recent historical and projected per capita income is shown in Table 5-8. The dollar amounts are somewhat meaningless without a reference point which the U. S. per capita average provides. The basin average has been slightly less than that of the U. S. and is projected to continue that trend. The Upper Subarea has equaled or been greater than the U. S. though projections are slightly less. The Middle and Lower Subareas's per capita incomes have been about 25 percent lower than the national average but this difference is projected to narrow. Constant dollar per capita income for the basin is projected to be about $12,522 in 2020 or 3.8 times greater than 1970.

Further personal income perspectives for the basin are shown in Table 5-9. Here, the percentages of families receiving $6,000 or greater and less than $3,000 annual actual income are shown for selected years in each of the three SMSAs (Houston, including Texas City - Galveston in this case). Corpus Christi is alone in not matching Statewide family income increases over the 20 year period. Those proportions of families above $6,000 increased as dramatically as the proportion under $3,000 decreased over time. The proportion of families receiving incomes between these two benchmarks also declined significantly over time. During the 20 year period family income, including inflation rose enough that those families under $6,000 were a smaller percentage in 1970 than the percent of families under $3,000 in 1950.

TABLE 5-8

Per Capita Personal Income of Subareas,
Historical and Projected

Texas Coastal Basins

Subarea	1950	1960	1970	2000	2020
	-----------------1967 $ (Dollars)--------------				
UPPER	2,184	2,418	3,468	7,957	12,857
TCB/U.S. Percent	106	97	100	98	97
MIDDLE	1,597	1,867	2,865	6,800	11,400
TCB/U.S. Percent	77	74	82	84	84
LOWER	1,586	1,836	2,681	6,600	11,300
TCB/U.S. Percent	77	73	77	81	85
BASIN	1,986	2,256	3,294	7,677	12,522
TCB/U.S. Percent	96	90	95	95	95
U.S.	2.064	2,498	3,476	8,100	13,200

Source: U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3, ERS

TABLE 5-9

Annual Family Income in Three Major Areas
and the State in 1950, 1960, 1970

Texas Coastal Basins

Area	Annual Family Income	Unit	1950	1960	1970
Beaumont-Port Arthur-Orange	$6000+	%	11	44	70
	Under $3000	%	46	24	13
	Median	$ 1/	3,206	5,493	8,711
Corpus Christi	$6000+	%	12	34	61
	Under $3000	%	52	34	16
	Median	$ 1/	2,770	4,428	7,509
Houston	$6000+	%	14	46	76
	Under $3000	%	46	23	10
	Median	$ 1/	3,172	5,602	9,890
State	$6000+	%	11	38	68
	Under $3000	%	55	29	13
	Median	$ 1/	2,680	4,884	8,535

1/ Actual dollars

Source: Texas Industrial Commission, Texas Regional Market Projections, 1950-1990, August 1973.

SELECTED MAJOR INDUSTRIAL GROUPS

Manufacturing

Manufacturing industries are immense boosters to the economy of the area. The Texas Coastal Basins is a significant source of supply for a wide variety of raw materials, such as the mined and extracted products, feed and food products, and fiber products. Manufacturing adds value to these materials by refinement, and production of intermediate products, and final consumer products.

Examples are oil refinery products, plastics, fertilizers, paper products, lumber, rubber, trailers, numerous chemicals, and rice and cottonseed products. The value added by these industries provides a common denominator by which scale and change in the economy can be measured. Table 5-10 shows reportable historical

TABLE 5-10

Manufacturing Value Added in Texas Coastal Basins by Subareas, Historical Selected Years, and Projections

Texas Coastal Basins

Subarea	Historical Values				Projected Values		
	1954	1958	1963	1967	1980	2000	2020
	1967 $ (Millions)						
Upper	1,349	1,831	2,695	4,030	7,910	19,028	45,393
Middle	180	246	337	638	1,347	3,261	7,736
Lower 1/	81	132	131	124	46	105	237

1/ Numerous sources are not reported to prevent disclosure of individual data.

Source: U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3.

values added for each of the subareas in this basin. The Upper Subarea is dominant in manufacturing with value added totaling $1.3 billion in 1954 and $4.0 billion in 1967. This subarea is also projected to increase more than tenfold by 2020. The center of this growth is Houston, located in Harris County, which has produced over one billion barrels of oil in its history and contains an inland turning basin for the Nation's second largest seaport. This city ranks first in oil field equipment manufacturing, petroleum refining, and pipeline transmission. It is one of the Nation's fastest growing cities.

Mineral Industries

The Texas Coastal Basins is the source of numerous minerals, mined from all areas of the basin. The Upper Subarea contains Spindletop, the State's first major oilfield. Oil and gas are the lifeblood of much of the manufacturing and servicing industries of the area. But the mineral industry here also includes oyster shell, sand, gravel, salt, sulphur, cement, clays and lime.

The array of mineral products exhibited in Table 5-11 for 1968 production provides insight to the scale of production and relative value between the products. Petroleum and natural gas, supplies to refineries, and gas transmission industries are dominant. Sulphur is a third high value output in the basin.

TABLE 5-11

Mineral Products, Quantities, and Values in 1968 1/

Texas Coastal Basins

Mineral	Unit	Quantity	Value
		-----000-----	1968 $ (000)
Petroleum	barrels	N.A.	931,381.0
Natural gas	million cubic feet	3,461.0	474,723.0
Caliche	short tons	487.0	305.8
Oyster shell	ton	7,850.7	10,784.8
Sulphur 2/	long tons	3,252.0	116,752.4
Salt 2/	short tons	7,851.1	39,255.5
Clay	short tons	1,205.0	1,589.8
Sand and Gravel	short tons	12,192.0	15,683.0

1/ Only minerals for which data were available are shown
2/ Estimated

Source: U. S. Bureau of Mines, Mineral Yearbook 1969. Vol. III, Area Reports: Domestic, 1970.

As shown in Table 5-12, mineral production values since 1954 have increased from $1.1 billion to $1.8 billion in 1969. Continued growth is projected to $3.2 billion in 2020. Output gains in the Lower Subarea have been greater in recent years, and that area now leads in total mineral production. In more recent years important oil and gas discoveries have been made in counties surrounding Corpus Christi.

TABLE 5-12

Value of Mineral Production in Texas Coastal Basins
By Subareas, Historical Selected Years and Projections

Texas Coastal Basins

	Historical Values				Projected Values		
Subarea	1954	1958	1963	1969	1980	2000	2020
	$millions						
Upper	497	475	514	672	840	1,075	1,411
Middle	261	294	340	486	632	827	1,021
Lower	316	324	428	597	681	693	747
Total Basin	1,074	1,093	1,282	1,755	2,153	2,595	3,179

Sources: U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3 and U. S. Bureau of Mines, Mineral Yearbook 1969, Vol. III, Area Reports: Domestic, 1970.

Agriculture

The diversity of characteristics within this basin are also expressed in the agricultural production pattern between subareas. Field crops dominate the broad variety of products of the basin. Rice, an irrigated crop, is the major cash crop of the basin with $171 million value and is produced in the Middle and Upper Subareas, Table 5-13. Grain sorghum, grown mostly in the Lower and Middle Subareas is the second leading cash crop followed by cotton. Other crops of the basin include flax, peanuts, vegetables, and sugar. Soybeans were introduced in recent years and have increased substantially. Though the 1970 value of soybeans produced was only about $3.4 million, 1974 production had increased to about $12.8 million.

Pasture and range forage production is utilized predominantly by cow-calf operations and some stocker grazing. Feedlot management and feeding of the grains produced in the area has not become characteristic of the area. Even though experimental work has shown that cattle on feed do as well on the coast as in other locations of the State, it has long been thought that high humidity, heat, and pests have been hinderances to such operations on the coast.

TABLE 5-13

Current Agricultural Production 1/

Texas Coastal Basins

(1970)

Land Use	Unit	Total Basin Production	Subarea Production Value Upper	Middle	Lower	Total Basin Value
		---000---	--------------$000--------------			
Cropland	ac	4,421	117,702	199,023	118,799	435,524
Nonirrigated	ac	3,356	23,336	90,240	110,744	224,320
Cotton	lb/lint	117,242	1,750	20,605	19,139	41,494
Gr. Sorghum	cwt	28,487	761	19,653	56,787	77,201
Soybeans	bu	851	3,168	261	---	3,429
Other	ac	2,615	17,657	49,721	34,818	102,196
Irrigated	ac	1,065	94,366	108,783	8,055	211,204
Cotton	lb/lint	11,116	71	2,136	1,727	3,934
Gr. Sorghum	cwt	1,107	56	635	2,307	2,999
Rice	lb	2,025,443	80,391	90,480	76	170,947
Other	ac	547	13,847	15,532	3,945	33,324
Pasture	ac	2,786	48,474	50,323	12,640	111,437
Range	ac	7,199	3,115	9,413	30,667	43,195
Total			169,291	258,759	162,106	590,156

1/ Based principally on Agricultural Price Standards, U. S. Water Resource Council, October 1974.

Source: ERS

The trend of crop acreages since 1949 is shown in Table 5-14. Acreages of most crops except grain sorghum and other hay have tended to decrease over time. Cotton and corn have experienced the largest decline of acreage. Production trends have not been directly related to these acreage declines, though. Corn was grown on one-third the acreage in 1949 but production has not dropped relative to that change. Rice acreage has dropped by about 11 percent while production is up about 80 percent. Grain

TABLE 5-14

Acreage and Production of Major Crops
Selected Years 1949 to 1970

Texas Coastal Basins

Crops	Unit	1949	1954	1959	1964	1970
		-----000-----				
Cotton.............	acres	855	677	605	574	363
Production.......	bales	525	458	369	461	259
Rice...............	acres	530	597	422	469	472
Production.......	bu.	23,513	35,424	29,820	43,358	45,010
Corn for grain.....	acres	379	324	347	215	128
Production.......	bu.	7,081	7,498	9,400	7,598	5,309
Sorghum for grain..	acres	329	511	831	598	896
Production.......	bu.	9,136	18,725	28,507	26,001	53,504
Sorghum for silage.	acres	100	171	92	45	40
Production.......	tons	194	281	298	175	103
Soybeans...........	acres	---	---	---	---	29
Production.......	bu.	---	---	---	---	851
Wild Hay...........	acres	81	82	89	77	64
Production.......	tons	80	67	121	98	94
Other Hay..........	acres	12	116	123	213	210
Production.......	tons	28	121	189	403	587
Other Crops Harvested	acres	252	116	68	90	86

Source: U. S. Department of Commerce, 1974 Census of Agriculture, Preliminary Report, December 1976.

sorghum production increased about 224 percent while acreage increased 171 percent. The majority of grain sorghum is grown in the non-irrigated Lower Subarea. The distribution of cropland use by crop, irrigated or non-irrigated and subarea is shown in Table 5-15.

TABLE 5-15

Cropland Use in Subareas, 1970

Texas Coastal Basins

Crop	Method 2/	Subareas Upper	Middle	Lower	Total
		Acres			
Cotton	D	14,400	169,700	157,700	341,800
	I	400	11,300	9,200	20,900
Rice	I	221,900	249,700	200	471,800
Corn	D	17,700	89,300	20,500	127,500
	I	---	---	100	100
Grain Sorghum	D	8,600	221,600	640,400	870,600
	I	500	5,300	19,300	25,100
Silage	D	7,700	17,300	14,600	39,600
	I	---	200	100	300
Soybeans	D	26,800	2,200	---	29,000
	I	---	---	---	---
Small Grains	D	4,300	7,200	42,300	53,800
	I	---	---	---	---
Wild Hay	D	24,900	38,700	100	63,700
Tame Hay	D	53,800	111,600	40,300	205,700
	I	2,200	1,900	200	4,300
Other Crops	D	24,500	16,400	24,100	65,000
	I	5,300	7,500	7,700	20,500
Cropland Pasture	D	194,300 1/	816,400 1/	162,900	1,173,600 1/
	I	269,200	242,800	4,300	516,300
Idle	D	88,500	175,300	121,900	385,700
	I	400	2,500	2,300	5,200
Total	D	465,500	1,665,700	1,224,800	3,356,000
	I	499,900	521,200	43,400	1,064,500

1/ Includes acreage in rice rotation. Pasture is a periodic use in this type rotation.
2/ D- Non-irrigated, I- Irrigated

Source: ERS, SCS

Value of farm products sold in the basin increased 89 percent between 1949 and 1969, Table 5-16. Livestock and their products increased much more than field crops especially between 1964 and 1969.

TABLE 5-16

Value of Farm Products Sold
Selected Years 1949 to 1969

Texas Coastal Basins

Product	1949	1954	1959	1964	1969
	---------------1967 $ (000)---				
Total Crops	150,550	209,240	164,055	217,911	231,141
Total Livestock and Products	91,762	81,172	134,705	125,307	229,731
Total Value	242,312	290,412	298,760	343,218	460,872

Source: U. S. Department of Commerce, 1974 Census of Agriculture, Preliminary Report, December 1976.

Indexes of crop and livestock projected values based on 1969 output were computed from OBERS E projections as expectations for the basins. These indexes do not constrain production in any further analysis of this study, but simply represent trend estimates, Table 5-17.

TABLE 5-17

Projected Subarea Indexes of Crop and Livestock
Values Based on 1969

Texas Coastal Basins

Subarea	Product Group	1969	1980	2000	2020
Upper	Crop	1.00	1.145	1.263	1.416
	Livestock	1.00	1.469	1.604	2.200
	Total	1.00	1.249	1.616	2.097
Middle	Crop	1.00	1.165	1.318	1.518
	Livestock	1.00	1.246	1.678	2.262
	Total	1.00	1.214	1.538	1.990
Lower	Crop	1.00	1.257	1.482	1.758
	Livestock	1.00	1.298	1.774	2.422
	Total	1.00	1.277	1.653	2.135

Sources: U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3.
U. S. Water Resources Council, 1972 OBERS Projections, Vol. 4.

Projected Agricultural Production

Baseline agricultural production projections for the Texas Coastal Basins are developed through a step-down procedure from U. S. Water Resources Council OBERS Series E' national and regional projections. The production quantities for various crops are not developed by simple long-term production slopes, but take into account changing factors which would affect future supply and demand. Those factors would include such as total population change rates, consumption rate changes, import-export long-term outlook and crop yield trends. The crops grown in any particular region would in turn reflect the national equilibrium quantities expected to be produced and known limitations or potentials of the region.

Projections for this basin are shown in Table 5-18. All crops production is expected to increase under baseline assumptions. Major increases are anticipated in soybeans, grain sorghum and rice. Cropland pasture inventory will tend to decline, being displaced by production of other cash crops. Remaining cropland pasture, pasture and range crop by-products and continuing technical and management improvements are expected to uphold livestock feed requirements.

TABLE 5-18

Baseline Agricultural Production

1970, 2000, and 2020

Texas Coastal Basins

Crop	Unit	1970	2000	2020
Cotton, lint	lb.	129,301	154,565	160,651
Rice	lb.	2,073,583	3,311,810	3,586,680
Corn	bu.	5,309	6,615	7,629
Grain Sorghum	cwt.	29,597	45,334	49,406
Silage	tons	103	151	157
Soybeans	bu.	515 1/	11,393	15,347
Small Grains	bu.	1,291	1,431	1,590
Wild Hay	tons	94	---	---
Tame Hay	tons	587	609	630
Other Crop Harvested	ac.	91	112	125
Cropland Pasture	ac.	1,714	1,250	1,250

1/ Production of soybeans in 1974 increased to approximately 3,200,000 bushels.

Source: U. S. Water Resources Council, 1972 OBERS Projections, Vol. 3

Forest Industry

The production, harvesting, and marketing of forest products is a significant part of the economy of the basin. In 1970 the stumpage value of sawtimber, poletimber, and pulpwood was approximately 27 million dollars. Seventy-four percent of the total volume was generated by sales of softwood products and 26 percent by sales of hardwood products. While employment rates, payroll dollars, and value added by manufacture in forest products industry are all measures for estimating economic conditions, value added by manufacture is the most significant, since it reflects capital investment (in the form of depreciation, interest, and profit), as well as payroll. Between 1958 and 1969, Texas ranked about midway with other southern states in all forest industry development.

Between 1958 and 1969, paper industry employment in the State led the South by growing 76 percent; whereas, lumber employment increased only 17 percent, Table 5-19. Paper industry value added compared to that of lumber industry for the same time frames, showing greater capital investment in the paper industry, which in turn, reflects higher average annual wages than the lumber industry. Despite the fact that sawtimber size and quality have decreased, forest products industries in the last 20 years have developed technologies which have improved utilization of timber and reduced manpower requirements. Many mills improved plant layouts and increased mechanization to reduce the impact of steadily rising wage rates. The lumber and wood products sector benefited from expansion of the softwood plywood industry. Output of this industry increased more than fivefold since 1947. Widespread adoption of technological improvements together with a flourishing market for sheathing grades of plywood enabled the industry to increase its productivity despite a drop in the quality of log input.

TABLE 5-19

Forest Industry Employment, Wages, and Value Added for State of Texas, 1969

Texas Coastal Basins

Industry By Years	Employment (Persons)	Wages-Average Annual Dollars	Value Added Million Dollars
Paper			
1958	9,700	-	111
1969	17,100	7,345	289
Lumber			
1958	17,100	-	78.6
1969	20,000	4,660	175.3

Source: FS

Floodwater Damage

Basin floodwater damages, mostly agricultural, are projected to increase in the future. The increase in damages is assumed to result primarily from an increase in the quantity and associated value of agricultural products produced rather than from extensive land use changes.

The total upstream flood plain area incurring damages is 7,296,500 acres and it is assumed that this acreage will remain constant over time. However, upstream flood damages are projected to increase from $66,660,000 in 1975 to $107,421,000 in 2000 and to $133,957,000 in 2020. These damages are based on present conditions. Projects under the ongoing program will reduce these damages to some degree. Increased estimated damages are based upon projected increase in value of agricultural production for the years 2000 and 2020. Rural floodwater damages relate directly to the management of land used for crops and pasture production and to a lesser degree to other rural land products. Both crop and pasture yields usually increase as flood hazards are minimized or eliminated.

Water Shortage

With many industries able to use large quantities of saline water, available water supplies have generally been adequate to meet the progressively increasing demands of the basin, although heavy overdraft of ground water aquifers in localized areas has substantially contributed to an increasingly menacing pair of problems - land subsidence and saline water intrusion. However, some areas are fast approaching critical shortages of fresh water.

One area facing a critical water shortage in the future is the Houston metropolitan area. Full development of the surface water resources of the San Jacinto River Basin, diversion from the Trinity River Basin, and ground water in the Gulf Coast aquifer should be capable of supplying the projected demands to about the year 2000 or beyond, assuming that pumpage of ground water from the aquifer is properly managed and is held to the "safe yield" of the aquifer.

Additional supplies from other sources will be required to meet long-range needs. With the projected rate of growth of the Corpus Christi and Kingsville areas, a probable shortage of freshwater will develop around the year 2000.

Present demands for irrigation water could be satisfied with existing water resources. However, projected increases will require further development such as interbasin transfers of water.

Estimated irrigation requirement needs for 2000 and 2020 reflect the level of irrigation that is projected to develop in the basin with the additional water supply. Water will be needed to supply the proposed 500,000 acres of irrigation in the Lower Subarea. By 2000 it is estimated that the annual requirement will be 596,800 acre-feet of which 523,730 acre-feet will need to be supplied from other sources. By 2020 the Lower Irrigation Project will be complete, requiring an estimated 937,400 acre-feet of which 867,140 acre-feet will need to be supplied from other sources.

Table 5-20 shows the current and projected irrigation acreage and water requirements. Provisions of the Texas Water Plan will satisfy these long-range requirements through interbasin transfer of projected surpluses in other river basins.

Continuing studies are being made to determine the freshwater needs to preserve the estuarine environment along the Texas Coast. Through the Texas Water Plan, every effort will be made to satisfy this need.

TABLE 5-20

Irrigation Water Requirements

Texas Coastal Basin

Subarea	1974		2000		2020	
	Acres	Ac-Ft	Acres	Ac-Ft	Acres	Ac-Ft
Upper	280,456	702,357	288,400	1,197,100	313,100	1,331,850
Middle	293,713	933,608	290,500	1,078,200	349,400	1,249,600
Lower	35,767	19,073	352,765	596,800	546,349	937,400
Basin Total	609,936	1,655,038	931,665	2,872,100	1,208,849	3,518,850

Source: Texas Water Development Board - 1968

Outdoor Recreation

In recent years, public desires, or the demand for outdoor recreational opportunities, have rapidly increased throughout Texas. Twenty-nine percent of the Texas population, or 3.2 million people, live within the Texas Coastal Basins which covers 13 percent of the State. Of this amount, one half million, or 22 percent, are living in rural areas. The remaining 2.7 million people live in towns, cities, and metro areas, and represent 30 percent of the urban population of Texas. The population is expected to increase greatly by the year 2000. Corresponding to this expected increase in population is an increased demand for leisure-time recreational activities.

The basin is also experiencing a dramatic increase in summer and winter visitation. This coastal area holds a great attraction for people from outside the basin and even out of State with its warm climate and the magnetism the ocean and its beaches have for people.

The demands for eight selected recreational activities are displayed in Table 5-21. These activities were previously discussed in Chapter 4. The data used to compile this information are based on studies by the Texas Parks and Wildlife Department for the Texas Outdoor Recreation Plan (TORP). Since the data in TORP were only projected to 2000, it was necessary to compute the 2020 projection by using the 1970, 1980, and 2000 time frames as reference points.

Participation in most of these selected activities will increase from six to ten times within the length of the study period. Some activities, such as trails and watersports will increase 20 and 24 times, respectively for the basin. Further information concerning this activity participation is shown in the Special Report on Outdoor Recreation, Texas Coastal Basins.

The Statewide inventory of facilities and surveys of demand by Texas Parks and Wildlife Department located facilities and resources by regions, and identified demand origins and destinations. By combining these data in a cascading routine, requirements of future population were projected to 1980 and 2000 by region.

The activity categories addressed in that study may be designated as shown in Table 5-22 for the Upper, Middle, and Lower Subareas. Shown are the existing (1970) and projected estimate of consumer trip expenditures associated with the supply of additional facilities or resources desired at standard rates of use. This would tend to underestimate 1970 expenditures in many activities that are overcrowded and overestimate the oversupplied facilities. However, projected years would not continue this variance.

The existing supply in some cases included an oversupply of resources for the present population and demand. Some of these are watersports, water for boat fishing, playgrounds, baseball fields, and hunting. Even these have specific locational deficiencies in comparison to demand studies. No basinwide resource desires were found to exist for hunting or boat fishing activities, present or projected. For those activities in oversupply of resources or facilities, projected desires do not reflect full participation because the desires are specified locational deficiencies only.

TABLE 5-21

Outdoor Recreation, Public Desires

Texas Coastal Basins

Activity	Subareas												Basin Total			
	Upper				Middle				Lower							
	1970	1980	2000	2020	1970	1980	2000	2020	1970	1980	2000	2020	1970	1980	2000	2020
	1000 Activity Days															
Camping	2113	4446	8872	12961	857	2314	5123	7784	2464	4963	7698	11241	5434	11723	21693	31986
Picnicking	5203	12564	26353	38834	1474	3989	8818	13364	2750	9996	20691	26096	9427	26549	55862	78294
Swimming	22212	45871	133287	276434	2889	6285	16541	31609	6023	15578	32898	47715	31124	67734	182726	355758
Golf	2469	4592	11614	22494	160	250	561	1054	305	468	966	1703	2934	5310	13141	25251
Child's Play	8387	16336	43136	85086	632	1135	2260	3550	1297	2202	4744	8303	10316	19673	50140	96939
Baseball/Softball	1475	2845	6311	10784	250	430	1004	1875	581	845	1573	2578	2306	4120	8888	15237
Trail Activity	28287	87378	296952	633543	4827	11993	31168	57068	3019	7978	25879	54197	36133	107349	353799	744808
Watersports	1064	6605	18377	31101	248	1313	3739	6575	370	1177	2486	3370	1682	9095	24602	41046

Source: Information compiled by River Basin Staff from data taken from Texas Outdoor Recreation Plan

TABLE 5-22

Outdoor Recreation Projected Additional Desires With Associated Consumer Trip Expenditures 1/

Texas Coastal Basins

Activity Category Subarea	1970 Direct Consumer Expenditure	1980 Additional Direct Consumer Expenditure	2000 Additional Direct Consumer Expenditure
	----------1970 $ (000)----------		
Water Based			
Upper	53,469	83,515	222,115
Middle	16,775	25,449	57,145
Lower	16,289	60,606	130,048
Total	86,533	169,570	409,308
Non-Water Based			
Upper	18,425	17,372	58,762
Middle	3,773	1,660	4,605
Lower	4,035	1,411	6,937
Total	26,233	20,443	70,304
Hunting, Inland			
Upper	11,240	0	0
Middle	6,618	0	0
Lower	5,654	0	0
Total	23,512	0	0
Hunting, Marsh			
Upper	392	0	0
Middle	504	0	0
Lower	216	0	0
Total	1,112	0	0
Total Recreation			
Upper	83,526	100,887	280,877
Middle	27,670	27,109	61,750
Lower	26,194	62,017	136,985
Grand Total	137,390	190,013	479,612

1/ Facility supply and projected additional desires based on Texas Parks and Wildlife data compiled by Soil Conservation Service. Consumer expenditures data based on secondary data sources and limited to trip expenditures.

Source: ERS

Consumer trip expenditures relate to direct purchases related to the activity experience not including costs for capital purchases or public administered cost. Public operation and administration costs are addressed separately. The consumer trip expenditures that might be associated with needed facility development indicate that the majority of projected expenditures are in the water related activities. Predominant activities are swimming and picnicking in each subarea. Approximately 60 percent of the overall consumer trip expenditure would be in the Upper Subarea with 13 and 27 percent in the Middle and Lower Subareas. The Upper Subarea non-water oriented group of activities compose an even higher percentage of needs and potential expenditure in relation to the rest of the basin.

The Texas Input-Output (I-O) Analysis, begun in 1968 and released in 1973, included Outdoor Recreation as one of the 175 individual sectors of which transactions and interdependence coefficients were developed. The I-O analysis indicates public funds spent in the operation and administration of outdoor recreation facilities by State agencies, counties and municipalities in Texas amounted to approximately $54.6 million, according to the Texas Input-Output Analysis for 1967. Texas Coastal Basins' share of O and A [1/] cost would amount to about $16.5 million. About 65 percent of the cost would be in the Upper Subarea.

The I-O interaction coefficients imply that households, or taxpaying citizens, pay for about 64 percent of the cost or $10.6 million in the Texas Coastal Basins. Based on the Input-Output Analysis direct input coefficient ($0.001136 per dollar of income), the level of household income required to support O and A expenditures of this scale is about $9.3 billion in 1970, which approximates Texas Coastal Basins household income.

TORP has described public desires that would require facility development to more adequately accommodate that demand. The need expressed for 1970 was for about 62.8 million activity days or 45 percent greater facility capacity in specified activities with the accompanying $4.8 million O and A cost.

The 1980 demand estimates indicate that desired levels would amount to 200.8 million activity days or 146 percent increase over 1970 facility supply. By 2000 632.8 million activity days or 1,020 percent increase.

1/ O and A - Operation and Administration expenditures by the Texas Parks and Wildlife Department.

Erosion and Sedimentation

The total environmentally acceptable amounts of sediment and erosion are shown in Table 5-23. The desired futures are based on the desire of the inhabitants of the basin to live in an environment which is as free as possible from environmental and economic limitations. This desire has been expressed in the past in the high rate of application of measures to reduce erosion and sedimentation. Most all of the basin shows a high degree of protection to the land base, and it is therefore reasonable to project a continuance of this trend into the future. The projections of the desired future conditions assume no restrictions so far as monetary or technical assistance to the landowners and operators within the basin.

One factor to be evaluated in determining the desired future amount of sediment to be delivered to the bays and estuaries is the need of estuarine and bay marine organisms for the nutrients associated with the sediment. It has been shown that complete elimination of the sediment loads to the bays and estuaries would probably be detrimental to marine organisms. Since the amount of sediment required by the bay and estuary ecology has not been satisfactorily defined, and arbitrary desired future of about 50 percent of present is assumed. Since it has not been shown that the losing of land to gully, streambank or shoreline erosion is environmentally or economically desirable, it is assumed that the desired future condition would include a major reduction of these damages. The same assumption is also made in regard to roadside erosion, flood plain scour damage and overbank deposition on the flood plain.

Resource Management Systems

The projected increases for the 50 year period 1970 - 2020 is based upon the assumption that 80 percent of the land can be adequately treated if there are no constraints. It is further assumed that an 80 percent level of Federal cost-sharing will supply the monetary incentive necessary for this goal to be attained. It must be recognized that a greater number of technical personnel would be necessary to "sell" conservation measures and supervise their installation.

It is estimated that about 68 percent of the land would be adequately treated by 2000 and 80 percent by 2020, Tables 5-24 and 5-25. The elimination of excess wetness would be the key conservation practice necessary for adequately treating acreages in all uses.

TABLE 5-23

Erosion and Sedimentation Summary, Total Desired Future Amounts

Texas Coastal Basins

	UPPER SUBAREA			MIDDLE SUBAREA			LOWER SUBAREA			BASIN TOTAL		
	Current	2000	2020	Current	2000	2020	Current	2000	2020	Current	2000	2020
DEL. SHEET TONS	1,307,400	1,261,600	1,093,600	2,459,300	1,744,400	1,211,600	2,903,700	1,777,700	1,068,500	6,670,400	4,783,700	3,373,700
DEL. GULLY TONS	268,200	134,100	13,400	207,200	103,600	10,400	50,900	25,500	2,500	526,300	263,200	26,300
DEL. STREAMB. TONS	785,900	393,000	39,300	308,300	154,200	15,400	92,600	46,300	4,600	1,186,800	593,500	59,300
DEL. ROADSIDE TONS	380,300	190,200	19,000	81,000	40,500	4,000	46,300	23,200	2,300	507,600	253,900	25,300
DEL. SHORELINE TONS	193,700	97,000	9,700	483,300	241,700	24,200	344,000	172,000	17,200	1,021,000	510,700	51,100
SCOUR ACRES ANN.	1,000	500	Negligible	3,000	1,500	Negligible	7,100	3,550	Negligible	11,100	5,550	Negligible
LAND LOST-GULLY Ac.	25	13	Negligible	24	12	Negligible	19	10	Negligible	68	35	Negligible
LAND LOST-STREAMB. Ac.	62	31	Negligible	38	19	Negligible	33	16	Negligible	133	66	Negligible
LAND LOST-SHORE. Ac.	39	20	Negligible	55	28	Negligible	15	8	Negligible	109	56	Negligible
OVERBANK DEPOSITION Ac.	19,400	9,700	Negligible	13,100	6,600	Negligible	6,900	3,500	Negligible	39,400	19,800	Negligible
SED. TO BAYS & EST. TONS	2,991,500	2,243,600	1,495,800	19,676,800	14,757,600	9,838,400	4,463,100	3,347,300	2,231,600	27,131,400	20,348,500	13,565,800

Source: River Basin Staff, SCS

TABLE 5-24

Land Treatment

Texas Coastal Basins
(2000)

Item	Cropland Non Irr.	Cropland Irr.	Pasture-land	Range-land	Forest Land	Other Agr. Land	Total Agr. Land	Non Agr. Land	Water	Total
UPPER SUBAREA										
Total Area (1000 Ac.)	391	437	1057	463	2334	164	5346	1492	453	7291
Adeq.Treated 1/ (1000 Ac.)	252	346	712	301	1976	112	3699	955	-	4654
Adeq.Treated (Percent)	64	79	67	65	70	68	69	64	-	68
MIDDLE SUBAREA										
Total Area (1000 Ac.)	1629	511	1242	1527	953	157	6019	359	484	6862
Adeq.Treated (1000 Ac.)	1280	403	919	829	855	128	4414	304	-	4718
Adeq.Treated (Percent)	79	79	74	54	90	82	73	85	-	74
LOWER SUBAREA										
Total Area (1000 Ac.)	1176	43	307	5043	179	234	6982	471	705	8158
Adeq.Treated (1000 Ac.)	837	37	239	2974	144	147	4378	295	-	4673
Adeq.Treated (Percent)	71	86	78	59	80	63	63	63	-	63
TEXAS COASTAL BASINS										
Total Area (1000 Ac.)	3106	930	2481	6897	3610	492	17516	3135	1657	22311
Adeq.Treated (1000 Ac.)	2369	786	1870	4104	2975	387	12491	1554	-	14045
Adeq.Treated (Percent)	76	85	75	60	82	79	71	50	-	68

1/ Properly used land with essential soil and water conservation measures applied.

Source: River Basin Staff, SCS

TABLE 5-25

Land Treatment

Texas Coastal Basins
(2020)

Item	Cropland Non Irr.	Cropland Irr.	Pasture-land	Range-land	Forest Land	Other Agr. Land	Total Agr. Land	Non Agr. Land	Water	Total
UPPER SUBAREA										
Total Area (1000 Ac.)	361	390	952	419	2751	126	4999	1836	456	7291
Adeq.Treated 1/ (1000 Ac.)	258	360	779	320	2191	114	4022	1454	-	5476
Adeq.Treated (Percent)	71	92	82	76	80	90	80	79	-	80
MIDDLE SUBAREA										
Total Area (1000 Ac.)	1595	499	1229	1493	918	147	5881	484	497	6862
Adeq.Treated (1000 Ac.)	1342	446	983	929	890	130	4720	372	-	5092
Adeq.Treated (Percent)	84	89	80	62	97	88	80	77	-	80
LOWER SUBAREA										
Total Area (1000 Ac.)	1150	41	300	4985	178	219	6873	579	706	8158
Adeq.Treated (1000 Ac.)	919	40	289	3910	158	190	5506	447	-	5953
Adeq.Treated (Percent)	80	98	96	78	89	87	80	77	-	80
TEXAS COASTAL BASINS										
Total Area (1000 Ac.)	3106	930	2481	6897	3847	492	17753	2899	1659	22311
Adeq. Treated (1000 Ac.)	2519	846	2051	5159	3239	434	14248	2273	-	16521
Adeq.Treated (Percent)	81	91	83	75	84	88	80	78	-	80

1/ Properly used land with essential soil and water conservation measures applied.

Source: River Basin Staff, SCS

Fishing and Hunting

The desires or demand of the public who are participating or wanting to participate in hunting and fishing are shown in Table 5-26. These public desires relate to the area of concern as described in Texas Fish and Wildlife Special Report.

The source of data used to compile this information was the Texas Outdoor Recreation Plan. However, TORP only showed projections to year 2000. In order for this section of the report to remain compatible with the rest of the report, projections to 2020 were computed from 1970, 1980, and 2000 time frames by either using a straight line or regression curve, Table 5-26.

The demand for fishing is limited to two types of rural fishing: Boat fishing and fishing from piers, barges, and marinas in the major lakes and reservoirs. Boat fishing is expected to increase nearly nine times in the Upper Coastal Subarea and approximately five times in the Middle and Lower Subareas from 1970 to 2020, Table 5-26. Fishing from piers, barges, and marinas will increase ten times in the Upper Subarea and five times in the Middle and Lower Subarea during this study period.

Two types of hunting are shown in this inventory - Inland and Marsh hunting. These are discussed further in Chapter 4. The demand for Inland hunting is expected to increase approximately four times in the Upper Subarea, five times in the Middle, and seven times in the Lower, Table 5-26. The expected demand increase for Marsh hunting from 1970 to 2020 is seven times in the Upper, six times in the Middle, and ten times in the Lower.

Archeological and Historical Resources

Inventories of archeological and historical sites have been conducted in recent years. Present classification criteria of what qualifies as one of these sites are vague. As time progresses more concern will emerge for preservation of natural and historic elements of our society. By the years 2000 and 2020, many old houses, buildings, and other sites will become historic and will be classified under some program carrying the authority to preserve the sites for future generations. Presently, historical societies and commissions are working to include more of such sites under existing classifications for preservation. Projections of the numbers of sites by categories to be preserved by time frame are shown in Table 5-27.

TABLE 5-26

Fishing and Hunting, Public Desires

Texas Coastal Basins

Activity	Subareas [1/] Upper				Middle				Lower				Basin Total			
	1970	1980	2000	2020	1970	1980	2000	2020	1970	1980	2000	2020	1970	1980	2000	2020
Fishing																
Boat																
Activity Days (X 1000)	5139	16939	28922	45053	3327	6038	10760	15732	769	1760	2662	3950	9235	24737	42344	64735
Acres	15000	55300	94500	147232	9800	18300	32500	47529	2800	6300	9300	14107	27600	79900	136300	208868
Pier																
Activity Days (X 1000)	466	1706	2913	4574	335	608	1084	1548	77	177	268	397	878	2491	4265	6519
Linear Yards	3500	13000	22300	35184	2300	4300	7600	10901	700	1500	2200	3254	6500	18800	32100	49339
Hunting																
Inland																
Activity Days (X 1000)	1405	2254	3563	5010	827	2637	3111	4708	707	1835	3373	5167	2939	6725	10047	14885
Acres	512900	782400	1242800	1789286	455300	956900	1662100	2477895	893500	2205300	3848300	6458750	1861700	3944600	6753200	10725931
Marsh																
Activity Days (X 1000)	49	134	214	326	63	227	339	528	27	81	181	283	139	442	734	1137
Acres	14500	36500	57800	88108	24100	87000	126000	195556	12900	38600	86200	134762	51500	162100	270000	418426

1/ These subareas were originally called coastal subunits in Special Report on Fish and Wildlife, which comprises a larger evaluation unit.

Source: Information compiled by River Basin Staff from data taken from Texas Outdoor Recreation Plan.

TABLE 5-27

Current and Projected Archeological and Historical Sites

Texas Coastal Basins

SUBAREAS	Historical	Archeological
UPPER		
1975	134	1,450
2000	100	30
2020	80	40
MIDDLE		
1975	150	911
2000	112	116
2020	90	116
LOWER		
1975	35	317
2000	25	30
2020	20	10
TOTAL		
1975	319	2,678
2000	237	176
2020	190	166

Source: Special Report - Historical and Archeological Resources - Texas Coastal Basins, 1975, SCS

Forest Production

The total desired future is to have every acre of forest land in maximum production of forest products in associated benefits. Historically, demand for timber products has increased as has the intensity of management to produce greater volumes of wood on a shrinking forest land base. Periodic timber inventories indicate greater volumes of wood are being produced as the condition and stocking are improved on more and more acres. Increasing demand for timber will result in greater volumes removed. The projected demands are as follows: 1980 - 176,400,000 cubic feet; 2000 - 208,100,000 cubic feet; 2020 - 207,500,000 cubic feet. Meeting the demand will increase the area of forest disturbances but not significantly enough to be a problem.

MAJOR LAND USES AND QUALITIES

Major categories of land use are shown in Table 5-28. The Upper Subarea includes the largest amounts of urban built-up, forest and Federal lands. The Middle Subarea includes the most cropland and is more balanced in remaining major uses. The Lower Subarea is 68.5 percent range with relatively little forest, pasture, or irrigated cropland. Most irrigated cropland is in the Middle and Upper Subareas, used primarily for rice production and its rotations.

The category defined as "urban built-up" in Conservation Needs Inventory data occupies about 5 percent of basin lands but covers 10 percent of the Upper Subarea land. This subarea has about 65 percent of the acreage used for this purpose. Included are built-up areas 10 acres or larger, roads, railroads, cemeteries, airports, institution sites - public and private, sporting sites, etc.

The use category "other" is comprised of farmstead roads, ditch banks, rural non-farm residences acreage, investment tracts, dunes, desert areas, marshes not grazed and various uses of these types. In different areas, the make-up of this category may be quite varied.

Water areas more than two acres but less than 40 acres were included as a measured surface area use in this inventory. This category also includes rivers and streams, not wider than one-eighth mile.

Federal land includes national forests, national parks, national wildlife refuges, U. S. military sites, and administrative sites. The majority in the Lower Subarea is Padre Island National Park. In the Middle Subarea it consists mostly of wildlife refuges. The Upper Subarea is primarily national forest land as noted in footnote to Table 5-28.

TABLE 5-28

Current Major Land Uses in Subareas

Texas Coastal Basins

Use	Upper Subarea Acres	Upper Subarea Percent	Middle Subarea Acres	Middle Subarea Percent	Lower Subarea Acres	Lower Subarea Percent	Basin Total Acres	Basin Total Percent
Cropland, Dry	465,507	6.4	1,665,707	24.3	1,224,846	15.0	3,356,060	15.0
Cropland, Irr.	499,905	6.8	521,200	7.6	43,443	.5	1,064,548	4.8
Pastureland	1,211,847	16.6	1,258,077	18.3	315,997	3.9	2,785,921	12.5
Rangeland	519,189	7.2	1,568,842	22.8	5,111,157	62.6	7,199,188	32.3
Forest Land	3,266,724 1/	44.8	988,444	14.4	180,114	2.2	4,435,282	19.9
Other Land	164,367	2.3	152,064	2.2	234,201	2.9	550,632	2.5
Urban built-up	692,503	9.5	203,920	3.0	193,979	2.4	1,090,402	4.8
Water Area <40 ac.	9,660	.1	12,037	.2	5,705	.1	27,402	.1
Water Area >40 ac.	437,920	6.0	444,312	6.5	695,291	8.5	1,577,523	7.1
Federal	23,640	.3	47,300	.7	153,044	1.9	223,984	1.0
Total	7,291,262	100.0	6,861,903	100.0	8,157,777	100.0	22,310,942	100.0

1/ This land use category includes 152,400 acres of Federally owned national forest land in addition to the Conservation Needs Inventory acreage of forest.

Source: River Basin Staff, SCS

Productive qualities of agricultural soils are identified and grouped according to cropping patterns, yield characteristics, responses to fertilizers and management. The general physical characteristics of each soil resource group are shown in Table 5-29. The groupings were developed by the Soil Conservation Service to permit an acceptable degree of accuracy in estimating and projecting crop yields.

The quanitities of each soil group and its major uses are shown in Table 5-30. About 80 percent of all cropland is found in SRGs 51 and 54. About 97 percent of all irrigation acreage is in these two SRGs. In the Upper Subarea about 40 percent of these two SRGsaare occupied by forests. Forests are distributed over numerous SRGs, though, including concentrations along riverbottoms, principally noted as 60 Series SRGs. Cropland concentrations in the Lower Subarea are distributed over more SRG variations. Irrigation acreage makes up less than four percent of the cropland in this subarea as opposed to 54 percent and 24 percent respectively for the Upper and Middle Subareas.

URBAN AND RURAL BUILT-UP AND PROJECTED ENCROACHMENT

Agricultural Acreage

Resources of the Texas Coastal Basins have a wide range of demands placed on them by a dynamic growing coastal community. This rapid growth is the result of a temperate climate, available water, access to international trade by way of Gulf ports, valuable underground minerals, tillable soil, manufacturing, and refining. Because there are so many social and industrial demands on the resources of this area, problem recognition and development planning is especially important for future years. A major concern is for land used in agriculture, or 90 percent of total land area.

Concern for land and water resource conservation and development planning calls for recognition of the various kinds of land-using activities, locational demands, and availabilities. Agriculture is a major, but none the less often residual user of land. For this reason, projected availability of soils for agricultural purposes must first consider non-agricultural land use changes. An analysis of change in population growth areas is particularly important. The residential development, public services, and industrial comparative economic advantage is almost always great enough to assure acquisition of the quantities demanded from agricultural uses, unless legislated otherwise.

It was postulated that if population and its associated land uses can be reliably related under varying conditions of concentrated

TABLE 5-29

Management-Productivity Soil Resource Groups

Texas Coastal Basins

Soil Resource Group (SRG)	General Description
51	Deep, fine textured, very slowly and slowly permeable soils.
52	Deep and moderately deep, fine textured, moderately permeable soils.
53	Moderagely deep, fine and medium textured, slowly and very slowly permeable soils and some shallow soils.
54	Deep, medium textured, slowly and very slowly permeable wet soils.
55	Deep, meduim textured, slowly and very slowly permeable soils.
56	Deep, medium and moderately coarse textured, moderately and moderately rapidly permeable soils.
57	Moderately deep, medium and moderately coarse textured, moderately and moderately rapidly permeable soils.
58	Deep, coarse textured, slowly and very slowly permeable soils.
59	Deep, coarse textured, thin and thick surfaced, moderately permeable soils.
61	Deep, coarse textured, rapidly permeable soils, wet.
63	Miscellaneous land types, non-arable.
64	Wet saline soils.
65	Clayey alluvial soils, well drained (fine textured-sandy clay, silty clay, clay).
66	Clayey alluvial soils, wet (fine textured-sandy clay, silty clay, clay).
67	Loamy alluvial soils, well drained (medium textured-very fine sandy loam, loam, silt loam silt, clay loam, sandy clay loam, silty clay loam).
69	Sandy and loamy alluvial soils, well drained (moderately coarse and coarse textured-sand, loamy sands, sandy loam, fine sandy loam).

Sources: SCS, ERS, TWDB

Table 5-30

Acreage of Major Agricultural Land Uses by Soil Resource Group
Upper Subarea

Texas Coastal Basins

Soil Resource Group	Dry Cropped	Irrigated Cropped	Pasture	Range	Forest	Other	Total
	---	---	---	Acres	---	---	---
51	184,851	262,333	306,688	91,902	257,564	36,579	1,139,917
53	1,410	-	4,606	298	5,092	203	11,609
54	186,670	259,168	348,187	92,818	947,421	33,066	1,867,330
55	5,766	-	66,621	9,279	409,865	7,060	498,591
56	39,961	93	143,164	53,886	439,652	33,182	709,938
57	-	-	46	-	-	-	46
58	4,770	-	79,527	12,124	400,994	3,273	500,688
59	2,091	-	51,982	-	122,065	7,843	183,981
61	-	-	2,056	13,633	42,120	3,812	61,621
63	280	-	33,602	19,413	23,839	27,044	104,178
64	640	429	56,567	189,180	7,049	4,763	258,628
65	554	973	-	24,678	44,091	416	70,712
66	2,608	1,168	93,587	9,249	401,506	3,482	511,600
67	11,647	-	25,214	2,729	13,066	309	52,965
69	-	-	-	-	-	3,335	3,335
Total	441,248	524,164	1,211,847	519,189	3,114,324	164,367	5,975,139

TABLE 5-30 (Cont'd)

Acreage of Major Agricultural Land Uses by Soil Resource Group
Middle Subarea

Texas Coastal Basins

Soil Resource Group	Dry Cropped	Irrigated Cropped	Pasture	Range	Forest	Other	Total
	--------	--------	--------	Acres	--------	--------	--------
51	877,610	182,894	503,635	313,514	128,153	36,009	2,041,815
52	97,806	1,211	51,350	43,259	9,597	2,896	206,119
53	5,897	-	5,670	5,259	2,061	107	18,994
54	403,009	327,453	353,563	615,120	317,741	30,759	2,047,645
55	40,967	-	52,749	34,991	21,709	2,796	153,212
56	41,854	5,306	97,095	114,105	44,078	18,206	320,544
57	6,511	-	6,920	2,990	214	751	17,386
58	46,817	-	60,130	85,872	239,017	9,967	441,803
59	1,963	-	16,758	5,236	5,176	1,027	30,160
61	1,298	-	1,309	4,613	10,924	5,012	23,156
63	-	835	3,625	44,573	7,341	31,041	87,415
64	-	104	5,428	40,548	-	-	46,080
65	63,004	906	51,377	74,329	116,980	5,940	312,536
66	29,935	1,087	11,192	104,434	49,575	3,505	199,728
67	45,564	1,404	32,928	62,814	29,372	3,470	175,552
69	3,472	-	4,348	17,285	6,506	578	32,189
Total	1,665,707	521,200	1,258,077	1,568,842	988,444	152,064	6,154,334

TABLE 5-30 (Cont'd)

Acreage of Major Agricultural Land Uses by Soil Resource Group
Lower Subarea

Texas Coastal Basin

Soil Resource Group	Dry Cropped	Irrigated Cropped	Pasture	Range	Forest	Other	Total
	-------	-------	-------	Acres	-------	-------	-------
51	672,358	19,352	134,651	659,817	2,044	33,315	1,521,53[illegible]
52	7,682	-	11,757	106,648	-	2,315	128,40[illegible]
53	72,433	-	63,988	605,635	82,602	6,416	831,07[illegible]
54	131,380	5,002	25,970	430,041	5,842	6,965	605,20[illegible]
55	72,449	9,782	6,767	320,598	4,061	11,231	424,88[illegible]
56	102,491	-	49,614	1,056,587	14,506	20,175	1,243,37[illegible]
58	73,567	759	11,927	1,163,511	31,611	17,589	1,298,96[illegible]
59	47,473	3,893	4,342	358,801	10,658	2,380	427,54[illegible]
61	-	-	-	91,241	489	10,380	102,11[illegible]
63	8,995	-	-	124,496	6,841	107,159	247,491
64	5,423	-	1,803	120,291	-	9,930	137,447
65	8,120	2,205	-	27,629	2,697	2,495	43,146
66	20,070	2,450	3,228	37,556	7,145	3,851	74,300
69	2,405	-	1,950	8,308	11,618	-	24,281
Total	1,224,846	43,443	315,997	5,111,157	180,114	234,201	7,109,758

Source: River Basin Planning Staff, SCS

social and industrial use, this relationship may be projected, within constraints, to compute the future acreage lost or gained to such use.

Relationships were developed between 1970 county population, and acreage composed of "urban built-up" plus "other infarm" uses in each county (as sampled and adjusted in the 1967 CNI).

Combination of the two use categories is viewed as representation of the whole population in land use instead of just urban, and the increasing interchange between urban and rural sites. The resulting relationships are wide ranging, characteristic of many comparative measures in the basin.

These ratios or coefficients applied to Texas Water Development Board projected county population changes quantify "urban and rural built-up" acreage needed in 1980, 2000 and 2020. A special adjustment in rate was made for the Harris County projections to reflect increased concentration.

Total land per inhabitant in counties of Texas Coastal Basins varies extremely. Probably the most uniform county-wide densities are across the Middle Subarea. The Upper Subarea, being more heavily populated, tends to have the least acreage per person, but varies considerably from county to county. The Lower Subarea is the least densely populated, but has wide fluctuations between counties. Kenedy County's 1,315 acres per person is an extreme that contrasts with the opposite extreme of 0.63 acre in Harris County of the Upper Subarea. Table 5-31 shows per capita acreages by county in each respective subarea. Per capita total land acreages are for total land per total population. The Texas Coastal Basins urban and rural built-up per capita acreage is higher than CNI rates because it includes additional rural domestic, business and service accommodations.

Urban and rural built-up acreage in 1970 is shown for each county or partial county in the subarea. The Upper Subarea contained the greatest amount of this land use category with 692,503 acres. The Middle and Lower Subareas both had about 30 percent as much. Projected requirements for urban and rural built-up acreage are shown for each county and subarea. By 2020, the Upper Subarea which includes Houston, Galveston-Texas City, and most of Beaumont-Port Arthur-Orange SMSA's would require about 1,802,100 acres for urban and rural built-up uses, while the Middle and Lower Subareas would require 406,600 and 465,100 acres, respectively. These data indicate that the Lower Subarea, containing Corpus Christi SMSA, will surpass the Middle Subarea in urban and rural built-up land requirements.

TABLE 5-31

Urban and Rural Built-up Acreage in 1970 and Projected
Upper Subarea

Texas Coastal Basins

Counties	1970 Per capita Total Land	1970 Per capita Built-up	1970 Total 1/ Built-up	2000 Total 1/ Built-up	2020 Total 1/ Built-up
	---	---	Acres	---	---
Brazoria	8.4089	.7701	42,000	104,000	181,800
Chambers	32.3545	1.2348	9,600	21,300	32,100
Fort Bend	10.6160	.3586	1,600	4,400	7,800
Galveston	1.5038	.2153	35,000	59,800	81,100
Grimes	43.2479	1.1367	3,400	2/	2/
Hardin	19.1292	.6708	19,200	37,200	55,100
Harris	.6332	.2568	427,800	838,600	1,108,000
Jasper	24.0376	.2724	2,200	4,000	5,800
Jefferson	2.4868	.3593	82,000	106,800	116,600
Liberty	22.9139	.9531	24,700	34,100	41,100
Montgomery	14.0950	.3236	15,100	47,300	96,600
Orange	3.2256	.4657	11,100	26,900	28,600
Polk	48.6784	.7423	6,300	6,700	6,700
San Jacinto	59.5882	.6337	2,000	2,800	3,300
Tyler	47.3673	.5170	3,600	6,300	9,700
Walker	18.2613	.4645	1,200	6,500	11,600
Waller	22.7461	1.5547	5,900	10,900	15,000

TABLE 5-31 (Cont'd)

Urban and Rural Built-up Acreage in 1970 and Projected
Middle Subarea

Texas Coastal Basins

Counties	1970 Per capita Total Land	1970 Per capita Built-up	1970 Total 1/ Built-up	2000 Total 1/ Built-up	2020 Total 1/ Built-up
	-----	-----	-Acre-	-----	-----
Austin	30.6604	2.3084	12,300	23,100	30,800
Brazoria	8.4089	.7701	39,000	96,800	130,200
Calhoun	18.9118	.8715	9,100	20,200	30,100
Colorado	34,4202	1.2330	11,500	2/	2/
DeWitt	31.2077	.8239	300	2/	2/
Fayette	33.8613	.6303	1,400	2/	2/
Fort Bend	10.6160	.3586	11,900	30,000	51,600
Goliad	114.4876	3.2039	2,500	2/	2/
Gonzales	41.2844	.6549	100	2/	2/
Grimes	43.2479	1.1367	-	-	-
Jackson	41,9416	1.0847	12,400	2/	2/
Lavaca	34.8546	1.8500	18,200	2/	2/
Matagorda	26.5373	.7380	16,800	25,700	32,200
Victoria	10.6202	.6078	24,000	25,300	50,000
Waller	22.7461	1.5547	9,400	14,500	23,900
Washington	20.7910	.8452	12,300	2/	2/
Wharton	18.7475	.8794	17,200	18,200	17,600

TABLE 5-31 (Cont'd)

Urban and Rural Built-up Acreage in 1970 and Projected
Lower Subarea

Texas Coastal Basins

Counties	1970 Per capita Total Land	1970 Per capita Built-up	1970 Total 1/ Built-up	2000 Total 1/ Built-up	2020 Total 1/ Built-up
	-----	-----	Acres	-----	-----
Aransas	19.4545	.6402	5,500	14,100	25,300
Bee	23.7006	1.0659	22,300	32,100	39,000
Brooks	72.2748	.8506	5,200	5,400	5,200
DeWitt	31.2077	.8239	200	2/	2/
Duval	98.9945	1.3266	7,300	2/	2/
Goliad	114.4876	3.2039	600	2/	2/
Jim Hogg	157.1947	1.2181	3,900	4,000	4,000
Jim Wells	16.3629	.4904	14,200	15,800	17,300
Karnes	36.0267	1.6129	900	2/	2/
Kenedy	1,315.6814	9.6431	3,200	3,500	3,900
Kleberg	16.166	.3209	9,000	13,800	23,500
Live Oak	100.1032	2.9910	5,100	2/	2/
McMullen	677.1726	4.5597	100	2/	2/
Nueces	2.2774	.7380	77,000	141,400	261,400
Refugio	52.1896	1.6455	6,500	2/	2/
San Patricio	9.1973	.9037	26,500	31,100	35,500
Starr	43.7558	.6549	2,500	3,200	4,200
Webb	30.0367	.4595	1,500	2,500	4,300

1/ A combination of urban built-up and miscellaneous non-urban homestead and rights-of-way acreage in Conservation Needs Inventory, in 1970.
2/ Projection of population resulting in constant to negative built-up acreage changes. Dependent on the type of current uses, socio-industrial might be assumed to remain stable or return to agriculture if its strategic location does not lend itself to supportive uses for population centers.

Source: ERS

A further distribution of projected urban and rural built-up land use changes within each county was made to each affected soil resource group (SRG). This distribution took into consideration population concentrations within soil associations as mapped by Soil Conservation Service, but otherwise proportionally allocated. Projected farm ponds and reservoir construction surface area is also included. The projected percentages of each SRG expected to be unavailable for agricultural production are exhibited in Table 5-32.

Soil resource groups 51, 54, and 56, three prime soils for agricultural production, are expected to absorb 70 percent of the basin's anticipated encroachment in both 2000 and 2020. Much of this will occur in the Upper Subarea where three SMSA's, principally Houston, are located. Without artificial constraints such as legislation at some level of government or some type of economic incentives these land use changes are anticipated.

TABLE 5-32

Projected Socio-Industrial Land Use Encroachment on the 1970 Agricultural Land Base, Identified as Percentages of Soil Resource Groups within the Subarea

Texas Coastal Basins

Soil Resource Group 1/	Upper Subarea		Middle Subarea		Lower Subarea	
	2000	2020	2000	2020	2000	2020
	Percent					
51	14.00	25.20	1.93	4.03	5.36	9.64
52	-	-	-	-	-	-
53	-	-	-	-	.00	1.00
54	11.00	18.40	1.29	2.80	2.07	3.68
55	8.08	10.80	-	.28	.83	1.40
56	15.80	27.00	2.78	5.37	.78	1.41
57	2.17	2.17	-	-	-	-
58	2.99	5.76	-	-	.14	.21
59	41.20	62.80	2.34	4.03	.05	.06
61	6.12	14.10	-	-	2.23	4.64
63	13.00	19.20	2.77	5.22	2.51	4.90
64	6.85	12.30	10.32	20.05	2.21	3.99
65	18.60	47.20	4.95	9.61	-	-
66	8.70	14.00	4.82	9.75	-	-
67	12.10	30.00	4.09	7.72	-	-
69	7.46	16.60	.83	1.31	.25	.20
Weighted Average	11.80	20.20	1.91	3.99	1.77	3.17

1/ Soil Resource Groups are combinations of soil series having productive management qualities which permit common grouping for analytical purposes.

Sources: ERS and SCS

CHAPTER 6

PROJECTED RESOURCE USE AND PRODUCTION WITHOUT ACCELERATED DEVELOPMENT

TEXAS COASTAL BASINS

CHAPTER 6

PROJECTED RESOURCE USE AND PRODUCTION WITHOUT ACCELERATED DEVELOPMENT

INTRODUCTION

The study of future water and related land uses requires definition of significant economic and environmental conditions which lend consistency and comparability to the data used.

Beginning with conditions that exist at present two projections of future conditions without and with planned resource development evaluate beneficial and adverse effects that may accrue as a result of the development. These projections are simply estimates of future conditions under carefully defined circumstances. A before and after comparison based on a status quo would not be helpful for analytical purposes because the problem and need elements are expected to change even without a plan. The basis of projected conditions planning is to evaluate the implications of certain trends and under stated assumptions extend those trends into the future. This chapter describes expected future basin conditions without a comprehensive plan of resource development.

ASSUMPTIONS CONDITIONING PROJECTED DATA

Projected conditions are based on long-run or secular trends and ignore cyclical fluctuations which characterize the short-run path of our economy. General assumptions that underlie the projections are:

1. Projections include anticipated development wherever the planners were assured that development would occur; assurances are based on implementation, authorizations such as existing and on-going programs, funded projects, projects under construction and operational projects as of December 31, 1976.

2. Baseline projections of agricultural production as quantified in OBERS Series E are representative of production expectations. Forest production projections in OBERS Series E are representative. General characteristics include:

a. Projections represent levels of production, consumption, exports and resource use that could occur given underlying assumptions, not targets to be achieved.

b. While total domestic consumption and real disposal income increases, income elasticity for food decreases.

c. Less than significant opportunity for large increases in product substitution will exist.

d. Continued growth in import demand by various countries constrained by policies of attaining self-sufficiency by major importers.

e. Uncertainty of recent trade patterns clouds all export projections. None the less, OBERS Series E assumes a definite level of exports.

f. The U. S. Economy will continue to expand without extended period of excessive inflation, depression or significant effects of wars.

3. The economy will become more efficient in satisfying human needs and wants. Specifically, agricultural technology and management will continue to improve.

4. Resources are known and limited in quantity.

5. Socio-industrial land uses including urban centers, towns, transportation routes, industrial tracts, rights-of-way etc. continue to be priority uses of land resources without legislation to constrain it.

PROCEDURE

Texas Statewide Agricultural Resources Study

In as effort to gain perspective and continuity with earlier resource development studies, the Texas Coastal Basins Area was identified as a portion of the Texas Statewide Agricultural Resource Study by the Texas Water Development Board, 1964-68. The task proved more difficult than first visualized because comparable area and resource identities were difficult to match, and results of the study were not published with the necessary linkages to easily identify such a mosaic of resource categories as found in this study area.

The report, Agricultural Resources Related to Water Development in Texas, was the result of Governor John Connally's directive to the Texas Water Development Board in 1964, to develop a comprehensive water plan for the State of Texas. This plan was to include a study of Texas water needs and projections through 2020.

The study coordinated through Water Resources Institute, of Texas A&M University, began by assembling an inventory of resources and soil capabilities and uses. Following this basic work, productive capacity projections were made with total production virtually unconstrained. Then, constraining projected production to market potentials for products from Texas, the future land and water requirements approach was used to determine future food and fiber needs. These food and fiber requirements were then projected as shares of U.S. future requirements, made available as preliminary projections by Economic Research Service of USDA. Texas' shares of national production were calculated from 1940-65 State data. Trendlines were developed and calculated as a percent of U.S. production for projected time frames.

Analyses were made for two conditions of water availability. One, called Model C, reflected judgement about production with no further water development. The second, Model D, reflected judgements about production shares with water available in particular areas through the Texas Water Plan. Products Statewide reflected increases of 16 to 100 percent with the Plan. The analyses; however, did not permit shifts of production location. Instead crops production was required to conform proportionally to the 1964 production pattern in each land resource area. Irrigated production to the extent of available water was mandatory. Conversion to cropland from other uses was on a programmed basis.

THE USDA ANALYSIS OF FUTURE CONDITIONS

The translation of projected production and social demands into demands for water and related land resources is the main effort in this chapter. A least-cost linear program was used as a vehicle to combine the many variables of future conditions and allocate resource uses to achieve projected output. Within constraints representing social and economic inability to change rapidly, production through this program gravitates to soils identified as available and lowest cost of production per unit.

The program is used as an aid, and the results must be interpreted as estimates of magnitude and direction of change.

Crop yields vary by soil quality and change over time. Beginning with a current normal, projected irrigated and non-irrigated crop yield changes are based on trends developed by specialists for the Water Resources Institute at Texas A&M University. Special adjustments were made to rice yields due to significant production changes, and data were gathered for soybeans, a relatively new crop in the area.

Cost of production per acre for specified crops represent variable cost production. Cost includes material, labor, and non-labor expenses for tillage and harvesting. Long-run cost of production trends exclusive of inflation trends represent changing technology and relate to increased yields. Tillage costs vary by major soil groups. Harvest cost varies by yield. Secondary sources of budgets were utilized with application of 1974 price index inflation differing for labor materials and machinery.

Land resources identified by soil resource group, subarea, major land uses, irrigated or non-irrigated, and specified agricultural uses establish the variable qualities and quantities with which we have to plan, using 1970 as a base.

Land uses associated with livestock production can be related, but the potential of pasture forages and range for development is so extensive and the possibility exists for so many combinations with other enterprises, scale adjustments, management and feed stuff substitutions, that pasture requirements is assumed of residual nature until resources are more limited.

Land use change constraints were used to prevent large scale and unrealistically fast changes in patterns of crop production or resource use. No shifts of land from pasture, range, forest or other categories were forced into cropland conversion after 1980, nor were they projected to increase.

With specified variation, crops were permitted to relocate between subareas 50 percent either way by 2000. By 2020, relocation was permitted by an increase of 80 percent or a decrease of 70 percent.

Cropland pasture is available for use in production of other crops which may be used primarily in rotation with rice. Some idle and rotational land is expected to remain, but rotational land would be increasingly utilized by crops such as soybeans and grain sorghum.

Urban and rural built-up land use encroaches on all categories of land use except other.(Percentages of soil resource group acreage lost to these uses are shown in Table 5-23 for each subarea and projected time periods.) The most extensive change is expected to occur in the Upper Subarea as detailed in Chapter 5.

Future Production

Projected baseline agricultural production, OBERS E', for this basin may be achieved through 2020 under the assumptions of this analysis. The projected value of agricultural production in the basin increased from $590 million in 1970 to $786 million in 2000 and $840 million in 2020. Irrigation farming products increased from $210 million to $338 million. Prices are constant dollars based on U.S. Water Resources Council Agricultural Price Standards of October 1974. These are normalized prices which in this era are often not reflective of current values, but are a standard reference. Product value in 1970 (Table 6-1) tended to concentrate in the Middle Subarea. Over time, this value tends to concentrate even more in that subarea for both dry and irrigated crops, Tables 6-2 and 6-3. Production values in the Upper Subarea tended to decline except for soybean production.

Value of this crop went from $3 million up to $22 million. The Middle Subarea increased all crops values with greater gains than other subareas in cotton, soybeans, rice and other crop categories. This subarea not only gained what production value the Upper Subarea lost, but absorbed new production as well. The Lower Subarea leads the basin in grain sorghum production value from both dry and irrigated farming.

The leading single crop in 2020 is rice, producing 89 percent of total irrigated output. The value of rice output is about 43 percent of total cropland output. Projected rice production is about one-third greater than that in the Texas Statewide Water Plan Condition. Cotton and corn projections are little different. Grain sorghum projections, though, are more than double that of the Statewide study. Recorded 1970 production occurred though irrigation acreage was minimal and the planned development nonexistent. Whether this production could be sustained in less favorable years is not certain. Soybeans meanwhile have become another major crop in the Texas Coastal Basins. An important

TABLE 6-1

Current Value of Agricultural Production 1/

Texas Coastal Basins

(1970)

Land Use	Unit	Total Basin Production	Subarea Production Value Upper	Middle	Lower	Total Basin Value
		---000 ---	$000			
Cropland	ac	4,421	117,702	199,023	118,799	435,524
Non-irrigated	ac	3,356	23,336	90,240	110,744	224,320
Cotton	lb/lint	117,242	1,750	20,605	19,139	41,494
Grain Sorghum	cwt	28,487	761	19,653	56,787	77,201
Soybeans	bu	851	3,168	261	-	3,429
Other	ac	2,615	17,657	49,721	34,818	102,196
Irrigated	ac	1,065	94,366	108,783	8,055	211,204
Cotton	lb/lint	11,116	71	2,136	1,727	3,934
Grain Sorghum	cwt	1,107	57	635	2,307	2,999
Rice	lb	2,025,443	80,391	90,480	76	170,947
Other	ac	547	13,847	15,532	3,945	33,324
Pasture	ac	2,786	48,474	50,323	12,640	111,437
Range	ac	7,199	3,115	9,413	30,667	43,195
Total			169,291	258,759	162,106	590,156

1/ Based principally on Agricultural Price Standards, U. S. Water Resources Council, October 1974.

Source: ERS

Table 6-2

Projected Value of Agricultural Production 1/

Texas Coastal Basins

(2000)

Land Use	Unit	Total Basin Production	Subarea Production Value			Total Basin Value
			Upper	Middle	Lower	
		----000---	--------$000--------			
Cropland	ac	4,185	145,156	357,760	136,899	639,815
Non-irrigated	ac	3,195	41,114	153,694	130,183	324,991
Cotton	lb/lint	145,500	1,842	29,510	20,140	51,493
Grain Sorghum	cwt	43,402	554	34,722	82,345	117,621
Soybeans	bu	11,393	23,918	21,997	-	45,914
Other	ac	1,830	14,800	67,465	27,698	109,964
Irrigated	ac	990	104,042	204,066	6,716	314,824
Cotton	lb/lint	9,064	58	1,742	1,408	3,208
Grain Sorghum	cwt	1,932	43	745	4,448	5,236
Rice	lb	3,311,810	86,534	192,896	87	279,517
Other	ac	421	17,408	8,683	773	26,864
Pasture	ac	2,609	42,264	49,782	12,303	104,349
Range	ac	7,043	2,776	9,222	30,261	42,259
Total			190,196	416,764	179,463	786,423

1/ Based principally on Agricultural Price Standards, U. S. Water Resources Council, October 1974.

Source: ERS

Table 6-3

Projected Value of Agricultural Production 1/

Texas Coastal Basins

(2020)

Land Use	Unit	Total Basin Production	Subarea Production Value			Total Basin Value
			Upper	Middle	Lower	
		----000---	--------$000--------			
Cropland	ac	4,037	130,958	411,624	156,725	699,308
Non-irrigated	ac	3,107	40,802	173,378	146,284	360,464
Cotton	lb/lint	150,658	1,881	30,877	20,560	53,318
Grain Sorghum	cwt	47,473	679	32,789	95,189	128,652
Soybeans	bu	15,347	22,417	39,432	-	61,849
Other	ac	1,796	15,825	70,285	30,535	116,645
Irrigated	ac	10	90,156	238,246	10,441	338,843
Cotton	lb/lint	9,992	64	1,920	1,552	3,536
Grain Sorghum	cwt	1,934	50	553	4,639	5,242
Rice	lb	3,586,678	75,637	227,011	67	302,715
Other	ac	420	14,405	8,762	4,183	27,350
Pasture	ac	2,486	38,076	49,341	12,013	99,430
Range	ac	6,911	2,515	9,040	29,911	41,466
Total			171,549	470,005	198,650	840,204

1/ Based principally on Agircultural Price Standards, U. S. Water Resources Council, October 1974.

Source: ERS

feature is its pattern of becoming a rotational crop on rice land, thus providing these farmers with a lucrative alternative. Coincidentally, the inventory of cropland pasture is reduced. In balance, the change brings about a generally more intensive and productive use of these prime soils.

Future Resources Use

Projections of future land and water resources by USDA permitted shifts in cropland use over time to accommodate various demands for land use. These factors include pressures from expanding urban and rural land uses, availability of water resources, and economy of production. Increasing agricultural output expectations and shrinking land availability are characteristic of this overview to 2020.

The base from which projections of land and water uses were made is shown in the 1970 composite of uses in Table 6-4. Quantities of land expected to be unavailable to agricultural use over time are summarized in Table 6-5. Total additional withdrawals beyond 1970 levels will be about 957,000 acres by 2000 and 1,721,000 acres by 2020. Over ninety percent of this acreage is for urban and rural built-up uses. Encroachment of these uses was investigated county by county relating potential growth centers and various per capita rates of use to soil resource groups and land use categories. Percentages of soil resource group acreage lost to urban and rural uses are shown in Table 5-32 for each subarea and projected time periods. The most extensive change is expected to occur in the Upper Subarea at each time period. Change in the Middle and Lower Subareas appears to be about the same.

It may be noted in studying projected land uses in Tables 6-6 and 6-7 that cropland will be reduced almost 400,000 acres by 2020. Pasture and range will each decline by about 300,000 acres. Because range land is predominantly in the Lower Subarea and away from large growth centers, it absorbs relatively less encroachment. Forest land, located in the proximity of population growth centers in the Upper Subarea, will absorb about 600,000 acres of socio-industrial encroachment.

Each subarea is projected to have less land categorized as cropland with the Middle Subarea continuing to have the largest amount. Over time, the actual loss of agricultural soils to other uses is greatest in the Upper Subarea, but the mix of crops is also slightly changed. Resource combinations became more competitive in the Middle Subarea, further reducing major crop production in the Upper Subarea.

TABLE 6-4

Current Major Land Use Distribution
Texas Coastal Basins

(1970)

Land Use 1/	Subareas Upper	Middle	Lower	Basin
	---------------------acres	-------------------	-------------------	-------------------
Cropland	965,400	2,186,900	1,268,300	4,420,600
Non-irrigated	165,500	1,665,700	1,224,900	3,356,100
Cotton	14,400	169,700	157,600	341,700
Grain Sorghum	8,600	221,600	640,400	870,600
Soybeans 2/	26,700	2,200		28,900
Other 3/	451,800	1,272,200	426,900	2,114,900
Irrigated	499,900	521,200	43,400	1,064,500
Cotton	300	11,300	9,200	20,800
Grain Sorghum	500	5,300	19,300	25,100
Rice	221,900	249,700	200	471,800
Other 3/	227,200	254,900	14,700	546,800
Pasture	1,211,800	1,258,100	316,000	2,785,900
Range	519,200	1,568,900	5,111,100	7,199,200
Forest land	3,266,700 4/	988,500	180,100	4,435,300
Other	164,400	152,000	234,200	550,600
Urban Built-up	692,500	203,900	194,000	1,090,400
Federal	23,600 5/	47,300	153,100	224,000
Water	447,600	456,300	701,000	1,604,900
Small (<40 ac.)	9,700	12,000	5,700	27,400
Large (>40 ac.)	437,900	444,300	695,300	1,577,523
Total	7,291,200	6,861,900	8,157,800	22,310,900

1/ Refer to CNI definitions.
2/ To be consistent with CNI this acreage may also be identified as irrigated land (rice rotation).
3/ Includes large acreages of rotational temporarily pastured and idle, as well as cropland.
4/ Includes 152,400 acres of National Forest.
5/ Not including 152,400 acres of National Forest.

Source: ERS and SCS

TABLE 6-5

Land Not Available for Agricultural Use

Texas Coastal Basins

	1970	2000	2020
	------------------------000 acres------------------------		
Urban Built-up			
Upper	693	1,310	1,812
Middle	204	300	438
Lower	194	314	424
Basin	1,091	1,924	2,674
Resource Reservation or Water Impounded			
Upper	176	267	269
Middle	47	76	87
Lower	153	157	158
Basin	376	500	514
Total Withdrawals			
Upper	869	1,577	2,081
Middle	251	376	525
Lower	347	471	582
Basin	1,467	2,424	3,188

Source: ERS and SCS

TABLE 6-6

Projected Major Land Use Distribution
Without Resource Development

Texas Coastal Basins

(2000)

Land Use	Subareas Upper	Middle	Lower	Basin
	acres			
Cropland	827,500	2,139,400	1,218,200	4,185,100
Non-irrigated	390,600	1,628,600	1,175,900	3,195,100
Cotton	7,200	115,500	78,800	201,500
Grain Sorghum	4,300	268,300	636,200	908,800
Soybeans	132,900	122,200	-	255,100
Other 1/	246,200	1,122,600	460,900	1,829,700
Irrigated	436,900	510,800	42,300	990,000
Cotton	200	5,700	4,600	10,500
Grain Sorghum	200	4,200	25,400	29,800
Rice	163,700	364,900	200	528,800
Other	272,800	136,000	12,100	420,900
Pasture	1,056,600	1,241,700	307,600	2,605,900
Range	462,700	1,527,100	5,043,500	7,033,300
Forest land	2,986,600 2/	953,200	179,300	4,119,100
Other	164,400	156,600	234,200	555,200
Urban Built-up	1,316,400	311,300	317,100	1,944,800
Federal	23,600 3/	47,300	153,100	224,000
Water	453,400	484,300	704,800	1,643,500
Small (<40 Ac.)	15,500	22,800	9,500	47,800
Large (>40 Ac.)	437,900	462,500	695,300	1,595,700
Total	7,291,200	6,861,900	8,157,800	22,310,900

1/ Includes large acreages of rotational, temporarily pastured and idle as well as other crops.
2/ Includes 152,400 acres of Federal forest land under jurisdiction of the U.S. Forest Service and 84,550 acres of forest land in newly purchased "Big Thicket Park" by National Park Service.
3/ Not included is 236,950 acres of Federal forest land of U.S. Forest Service and National Park Service administration shown under Forest land use category.

Source: ERS

TABLE 6-7

Projected Major Land Use Distribution
Without Resource Development

Texas Coastal Basins

(2020)

Land Use	Subareas Upper	Middle	Lower	Basin
	acres			
Cropland	751,800	2,093,600	1,191,700	4,037,100
Non-irrigated	361,500	1,594,900	1,150,400	3,106,800
Cotton	7,200	118,400	78,800	204,400
Grain Sorghum	4,300	207,100	601,400	812,800
Soybeans	106,200	187,000	-	293,300
Other 1/	243,700	1,082,400	470,200	1,796,300
Irrigated	390,300	498,700	41,300	930,300
Cotton	200	5,700	4,600	10,500
Grain Sorghum	200	2,700	22,300	25,200
Rice	118,600	355,800	100	474,500
Other 1/	221,300	134,500	14,300	420,100
Pasture	951,900	1,228,700	300,300	2,480,900
Range	419,100	1,492,800	4,985,200	6,897,100
Forest land	2,751,200 2/	917,900	178,600	3,847,100
Other	126,400	147,400	219,400	493,200
Urban Built-up	1,811,300	437,600	424,000	2,672,900
Federal	23,600 3/	47,300	153,100	224,000
Water	455,900	496,600	706,100	1,658,600
Small (<40 Ac.)	18,000	27,100	10,800	55,900
Large (>40 Ac.)	437,900	469,500	695,300	1,602,700
Total	7,291,200	6,861,900	8,157,800	22,310,900

1/ Includes large acreages of rotational, temporarily pastured and idle as well as other crops.
2/ Includes 152,400 acres of Federal forest land under jurisdiction of U.S. Forest Service and 84,550 acres of forest land in newly purchased "Big Thicket Park" by National Park Service.
3/ Not included is 236,950 acres of Federal forest land of U.S. Forest Service and National Park Service administration shown under forest land use category.

Source: ERS

Over time some yield increases trends apparently are equal to or greater than projected total production. By 2000 rice and grain sorghum crop acreages showed an increase but by 2020 acreage for these crops had declined.

Irrigation acreage will decline from about 1,065,000 acres in 1970 to 990,000 acres in 2020. While total irrigation was declining, rice land which is irrigated when not in rotation increased slightly. The decline of irrigation acreage inventory is reflected most in the cropland pasture category since much of that land is principally rice rotation land. With new rotation enterprises involving soybeans or grain sorghum some irrigation soils (and coincidentally cropland pasture) lose that identity when production is by dry farming. Because rice requires a rotation either to idle or another crop a balance must be maintained to reflect that acreage in the rotation stage. In these projections, that requirement has been met and the rotation land is primarily in cropland pasture and soybeans production.

Forest Production

Production efficiency is expected to improve through (1) improving the ratios of well stocked forest to total forest (2) more efficient forest utilization and (3) improved application of fire and pest control technology should avert an increase in mortality rates for these causes.

Net annual growth will increase from 123 million cubic feet in 1970 to 192 million feet in 2020. However, as stated in Chapter 5, forest products demand will increase at an even faster rate so that by 1990, the demand will catch up and surpass the supply; in 2020 demand will exceed the supply by 15 million cubic feet, a deficit that will have some influence on the basin's economic development.

Sediment from Forest Land

As the increasing demands for forest products accelerate timber harvesting operations, higher sediment yields are expected in a direct proportion of the rate of increase of forest production. The results are the same whether or not the disturbance is one of intensity, scope, or both.

The 2000/1970 net annual growth rate ratio is 1.49

The 2020/1970 ratio is 1.55

Non-timber related disturbances should stay at the 1970 level. Applying the derived ratios to the 1970 logging disturbance rates will yield the data presented in Table 6-8.

It's obvious that the average soil loss rate will remain within established tolerances for on-site erosion damage or fertility loss. Do not forget, though, that included in this "acreage" situation are many small local eroding areas and erosion hazards. The problem will require careful monitoring and attention to keep it within bounds. Current forest erosion programs provided by the Texas Forest Service through several water-related cooperative Federal programs appear adequate to do the job.

EXISTING PROJECTS AND PROGRAMS

The future without plan conditions reflect the basin's future based on the continuation of present programs but at uncertain rates. Some programs change from year to year while others remain constant or are cancelled. Generally, the following outlines the on-going programs that affect the problems and conditions in the basin.

Flooding

Projections of floodwater damages were made for the upstream watersheds. Existing programs to reduce flooding include the Watershed Protection and Flood Prevention Act (PL 83-566) and the Resource Conservation and Development Program. The watershed projects and the RC&D project measures that are planned and approved for operations were assumed to be completed by 2000.

Land Treatment

Projections of land treatment needs were made. These needs include measures to reduce erosion, excess water, sediment, and to prevent deterioration of the agricultural land base.

Available programs for land treatment include watershed projects under PL-566 and RC&D project measures. These projects include critical area treatment as well as other conservation measures.

Other land treatment programs provide technical assistance and/or financial assistance. These programs include technical assistance provided by the SCS under PL 74-46, Agricultural Stabilization and Conservation Service Assistance, Extension Service assistance, and U.S. Forest Service programs, among others.

Table 6-8

Projected Average
Annual Sediment Delivered from Forest Land 1/

Texas Coastal Basins

Disturbance	1970 M Tons	1980 M Tons	2000 M Tons	2020 M Tons
Natural	2.0	2.0	2.0	2.0
Logging	7.3	9.3	10.9	11.3
Skid Trails	1.8	2.3	2.7	2.8
Spur Roads	62.7	79.8	93.3	97.1
Site Preparation	-	-	-	-
Chopping	8.7	11.1	13.0	13.5
Discing	12.2	15.5	18.2	18.9
Fire	0.1	0.1	0.1	0.1
Grazing	69.8	69.8	69.8	69.8
TOTAL	164.6	189.9	210.0	215.5
ACRES (M)	4,435	4,400	4,119	3,847
Av. RATE/ACRE	0.037	0.043	0.051	0.056

1/ This reflects larger areas of disturbances due to more timber removal in future time frames.

Source: FS, USDA

Erosion and Sedimentation

The reduction of erosion and sedimentation will be the result of installation of flood damage reduction and land treatment measure programs.

Recreation

Recreation facilities identified include those presently existing. The RC&D program and the watershed program, among others, provide some means to meet recreation demands.

Fishing and Hunting

Existing resources are more than adequate to meet projected demands basinwide. Programs should be implemented which will provide hunting and fishing opportunities.

Archeological and Historical Sites

Projections for archeological and historical sites to be preserved assumed that existing State and local programs would accomplish these tasks with some Federal aid. The Texas Historical Commission, within its limited authority, would provide for the preservation or protection of identified sites.

SPECIFIC DESCRIPTION OF FUTURE WITHOUT PLAN CONDITIONS

Flooding

Future without plan conditions indicates that acreage flooded will be reduced by a minimal amount in the upstream watersheds. As already indicated, 7,296,500 acres in 109 upstream watersheds are subject to flooding and are assumed to remain the same in 2000 and 2020. Also, the associated monetary damages are estimated at $66,660,000 in 1975 and are projected to increase to $107,421,000 in 2000 and to $133,957,000 in 2020. It should be noted that these estimates are a forecast of the present flooding problem and do not reflect the beneficial effects of existing programs.

Existing programs will reduce the area subject to flooding by a minimal amount. Floodwater damage in the basin occurs primarily on agricultural flatlands. It was assumed that project measures would provide 5-year frequency protection on rural areas.

Deducting the beneficial effects of the existing program from the present and projected flood damage situation reflects the upstream estimated flood damages without plan conditions, Table 6-9.

Land Treatment

The projected land treatment for the without plan conditions is based upon the approximate rate of accomplishment over the past 30 year period from 1940-1970, Table 6-10. Estimates of Soil Conservation Service personnel generally serve to confirm these projections; however, in some instances these county estimates served as a tempering force of realism. Also, Federal cost sharing is projected to be 50 percent for applying essential practices necessary to adequately treat the land. The assumption is also made that technical assistance will be available.

Shifts in all agricultural and forest land uses will be toward urban industrial. In the Upper Subarea during 1970-2000 the acreage of all agricultural uses declined while urban-industrial increased almost 100 percent. The same trend occurred, though not as drastic throughout the basin.

The amount and percentages of land adequately treated is expected to increase in each period. The rate will decrease after 2000 as the most progressive and cooperative land users adequately treat their land. Table 6-11 reveals about 53 percent will be adequately treated by 2000. The Middle Subarea historically has had a higher percentage of land adequately treated. The removal of excess water is the most critical essential treatment practice. By 2020 approximately 60 percent of the land will be adequately treated, Table 6-12. The land adequately treated will probably reach an equilibrium at this level due to areas infeasible to treat, constant changes in ownership and reluctance of landowners to install needed conservation measures because of the low rate of monetary return.

Recreation

The existing and projected facilities for each selected outdoor recreational activity and the activity days supplied by these facilities are shown in Table 6-13.

In order to project future developments for without plan conditions it was necessary to rely on historical data of past recreational developments. The source of data utilized for this data was the individual county surveys in which the Texas Parks and Wildlife Department's Comprehensive Planning Branch made during their recreational inventory in producing the Texas Outdoor Recreation Plan (TORP).

TABLE 6-9

Upstream Floodwater Damages
Future Without Plan Conditions

Texas Coastal Basins

	LOWER SUBAREA						MIDDLE SUBAREA					
	1975		2000		2020		1975		2000		2020	
	Rural 2/	Urban 2/	Rural 2/	Urban 2/	Rural 2/	Urban 2/	Rural 2/	Urban 2/	Rural 2/	Urban 2/	Rural 2/	Urban 2/
Projected												
Ac. 1/	919.8	56.2	905.1	70.9	892.3	83.7	3,382.5	64.8	3,328.6	118.7	3,265.1	182.2
$ 1/	2,907.0	5,168.0	3,746.0	6,520.0	3,642.0	7,697.0	20,159.0	5,958.0	25,979.0	10,914.0	25,263.0	16,753.0
Reduction by Existing Programs												
Ac. 1/	0	0	0	0	0	0	0	0	0	4.9	0	2.0
$ 1/	0	0	0	0	0	0	0	0	1,104.0	451.0	2,640.0	184.0
W/O Plan												
Ac. 1/	919.8	56.2	905.1	70.9	892.3	83.7	3,382.5	64.8	3,328.6	113.8	3,265.1	180.2
$ 1/	2,907.0	5,168.0	3,746.0	6,520.0	3,642.0	7,697.0	20,159.0	5,958.0	24,875.0	10,463.0	22,623.0	16,569.0

	UPPER SUBAREA						TOTAL BASIN					
	1975		2000		2020		1975		2000		2020	
	Rural 2/	Urban 2/	Rural 2/	Urban 2/	Rural 2/	Urban 2/	Rural 2/	Urban 2/	Rural 2/	Urban 2/	Rural 2/	Urban 2/
Projected												
Ac. 1/	2,565.1	282.6	2,283.2	564.5	2,059.5	788.2	6,067.4	401.6	6,516.9	754.1	6,216.9	1,054.1
$ 1/	6,402.0	25,986.0	8,354.0	51,903.0	8,124.0	72,478.0	29,548.0	37,112.0	38,079.0	69,342.0	37,029.0	96,928.0
Reduction by Existing Programs												
Ac. 1/	0	0	0	94.1	0	0	0	0	0	99.0	0	2.0
$ 1/	0	0	0	8,652.0	0	0	0	0	1,104.0	9,103.0	2,640.0	184.0
W/O Plan												
Ac. 1/	2,565.1	282.6	2,283.2	470.4	2,059.5	708.2	6,867.4	403.6	6,516.9	655.1	6,216.9	1,052.1
$ 1/	6,402.0	25,906.0	8,354.0	43,256.0	8,124.0	72,478.0	29,548.0	37,112.0	36,975.0	60,239.0	34,389.0	96,744.0

1/ In 1000's
2/ It is assumed that all projects to be installed under existing and on-going programs will be installed in the Middle Subarea due to the higher B-C ratios in this subarea. It is further assumed that 5-year channels will be installed in rural areas and 100-year channels will be installed in urban areas. It is assumed that 5-year channels will have negligible effect on the total acres flooded.

Source: River Basin Staff, SCS

Table 6-10

Land Treatment

Texas Coastal Basins

(1970)

Item	Cropland Non Irr.	Cropland Irr.	Pasture land	Range-land	Forest Land	Other Agr. Land	Total Agr. Land	Non Agr. Land	Water	Total
UPPER SUBAREA										
Total Area (1000 Ac.)	441	524	1212	519	3114	164	5974	869	448	7291
Adeq. Treated (1000 Ac.) 1/	75	133	268	294	841	76	1686	403	-	2089
Adeq. Treated (Percent)	17	25	22	57	27	46	28	47	-	31
MIDDLE SUBAREA										
Total Area (1000 Ac.)	1666	521	1258	1569	988	152	6154	251	456	6862
Adeq. Treated (1000 Ac.)	481	152	541	362	830	105	2471	173	-	2645
Adeq. Treated (Percent)	29	29	43	23	84	69	40	69	-	41
LOWER SUBAREA										
Total Area (1000 Ac.)	1225	43	316	5111	180	234	7110	347	701	8158
Adeq. Treated (1000 Ac.)	475	15	178	1229	178	204	2279	303	-	2582
Adeq. Treated (Percent)	39	35	56	24	99	87	32	87	-	35
TEXAS COASTAL BASINS										
Total Area (1000 Ac.)	3332	1089	2786	7199	4283	551	19239	1467	1605	22311
Adeq. Treated (1000 Ac.)	1030	300	986	1886	1849	385	6436	879	-	7316
Adeq. Treated (Percent)	31	55	35	26	43	70	33	60	-	35

1/ Properly used land with essential soil and water conservation measures applied.

Source: USDA Conservation Needs Inventory, 1970.

Table 6-11
Land Treatment
Texas Coastal Basins
(2000)

Item	Cropland Non Irr.	Cropland Irr.	Pasture-land	Range-land	Forest Land	Other Agr. Land	Total Agr. Land	Non Agr. Land	Water	Total
UPPER SUBAREA										
Total Area (1000 Ac.)	391	437	1057	463	2834	164	5346	1492	453	7291
Adeq.Treated 1/ (1000 Ac.)	159	233	458	320	1474	110	2754	747	-	3501
Adeq.Treated (Percent)	41	53	43	69	52	67	52	50	-	51
MIDDLE SUBAREA										
Total Area (1000 Ac.)	1629	511	1242	1527	953	157	6019	359	484	6862
Adeq.Treated (1000 Ac.)	988	276	867	648	903	106	3788	192	-	3980
Adeq.Treated (Percent)	61	54	70	42	95	68	63	53	-	62
LOWER SUBAREA										
Total Area (1000 Ac.)	1176	43	307	5043	179	234	6982	471	705	8158
Adeq.Treated (1000 Ac.)	528	33	229	2178	170	150	3288	268	-	3556
Adeq.Treated (Percent)	45	77	75	43	95	64	47	57	-	48
TEXAS COASTAL BASINS										
Total Area (1000 Ac.)	3106	930	2481	6897	3610	492	17516	3135	1657	22311
Adeq.Treated (1000 Ac.)	1675	542	1554	3146	2547	366	9830	1207	-	11037
Adeq.Treated (Percent)	54	58	63	46	71	74	56	39	-	53

1/ Properly used land with essential soil and water conservation measures applied.

Source: River Basin Staff, SCS

Table 6-12
Land Treatment
Texas Coastal Basins
(2020)

Item	Cropland Non Irr.	Cropland Irr.	Pasture-land	Range-land	Forest Land	Other Agr. Land	Total Agr. Land	Non Agr. Land	Water	Total
UPPER SUBAREA										
Total Area (1000 Ac.)	361	390	952	419	2751	126	4999	1836	456	7291
Adeq.Treated (1000 Ac.) 1/	194	297	460	366	1389	113	2819	1036	-	3855
Adeq.Treated (Percent)	54	76	48	87	51	90	56	56	-	56
MIDDLE SUBAREA										
Total Area (1000 Ac.)	1595	499	1229	1493	918	147	5881	484	497	6862
Adeq.Treated (1000 Ac.)	1048	314	941	735	908	100	4046	297	-	4343
Adeq.Treated (Percent)	66	63	77	49	99	68	69	61	-	68
LOWER SUBAREA										
Total Area (1000 Ac.)	1150	41	300	4985	178	219	6873	579	706	8158
Adeq.Treated (1000 Ac.)	563	37	250	2671	175	173	3869	324	-	4193
Adeq.Treated (Percent)	49	90	83	54	98	79	56	56	-	56
TEXAS COASTAL BASINS										
Total Area (1000 Ac.)	3106	930	2481	6897	3847	492	17753	2899	1659	22311
Adeq.Treated (1000 Ac.)	1805	748	1673	3872	2250	386	10734	1657	-	12391
Adeq.Treated (Percent)	58	80	67	56	58	78	60	57	-	60

1/ Properly used land with essential soil and water conservation measures applied.

Source: River Basin Staff, SCS

Table 6-13

Outdoor Recreation
Future Without Project or Plan

Texas Coastal Basins

Activity	Subareas									Basin Total		
	Upper			Middle			Lower					
	Current	2000	2020	Current	2000	2020	Current	2000	2020	Current	2000	2020
Camping												
Activity Days(1000)	808	1293	1616	363	581	762	487	779	955	1658	2653	3333
Sites	1500	2400	3000	470	752	987	1100	1760	2150	3070	4912	6137
Picnicking												
Activity Days(1000)	4819	7229	8674	1004	1406	1707	1649	2803	3628	7472	11438	14009
Tables	3600	5400	6480	1000	1400	1700	1200	2040	2640	5800	8840	10820
Swimming												
Activity Days(1000)	5957	10127	12510	336	504	1613	2295	3443	4361	8588	14074	18484
Square Yards (1000)	57	97	120	58	74	78	16	23.5	29.5	131	194.5	227.5
Golf												
Activity Days(1000)	1000	1600	2200	476	666	857	331	497	596	1807	2763	3653
Holes	226	202	227	207	290	373	126	189	227	559	915	877
Child's Play												
Activity Days(1000)	14609	21914	26296	3182	3500	4137	5640	9024	9588	23431	34438	40021
Acres	600	900	1080	100	110	130	200	260	340	900	1270	1550
Baseball/Softball												
Activity Days(1000)	5806	8128	10450	1048	1886	2215	372	595	781	7226	10609	13446
Fields	340	476	612	80	144	192	40	64	84	460	684	868
Trails												
Activity Days(1000)	1735	2950	3643	50	50	50	256	256	256	2041	3256	3949
Miles	170	289	357	9	9	9	36	36	36	215	334	402
Watersports												
Activity Days(1000)	13321	13321	13321	2065	3170	4477	4807	4807	4807	20193	21298	22605
Surface Acres	70000	70000	70000	34000	52200	59200	16500	16500	16500	120500	138700	145700

Source: Information compiled by River Basin Staff from data furnished by the Texas Parks and Wildlife Department (TPWD).

The recreational developments within these counties of the basin were aggregated into ten-year time spans for each subarea from 1919 to the present. This was used as a basis for projecting facility developments through 2020.

The projected surface acres of water suitable for the watersports activity was taken from data furnished by the Texas Water Development Board. Three reservoirs are expected to be constructed in this study period. These are Palmetto Bend Nos. 1 and 2, with 18,200 surface acres and the South Texas Project, with 7,000 surface acres in the Middle Subarea.

By year 2000 the disparity of needed development between the non-accelerated condition and TORP projection is over one half billion activity days, or about 90 percent less. The shares of public expenditure for outdoor recreation coming from households would require a greater income base from which to generate these funds. The TORP level of development would require over $42 billion of additional household income while the nonaccelerated condition would call for over $3 billion. These requirements compare with baseline projections of $6.8 billion additional earnings. On the basis of income per household, implication is that the average household income for the respective conditions would need to increase about $33,800, for TORP, and $2,700 for non-accelerated in order for the tax rate to remain the same or for the development to be subsidized from some other source.

Fishing and Hunting

The inventory of the present and projected resources available for fishing and hunting are presented in Table 6-14, by activity days and facilities. These resources were inventoried within a larger evaluation unit used in Texas Fish and Wildlife Special Report.

Freshwater fishing has been categorized into two types - boat fishing and pier fishing. The evaluation unit presently has 273,720 suitable surface acres of water providing 84.8 million activity days of boat fishing. These resources will remain the same in the Upper and Lower Subareas, whereas the Middle Subarea, with the construction of Palmetto Bend Reservoir and South Texas Project will receive an additional 25,200 suitable surface acres of water for boat fishing providing an additional 7.3 million activity days from 1970 to 2020.

The facilities for pier fishing are shown to remain the same throughout this study. A total of 5,100 linear yards of fresh water fishing piers presently exist in the evaluation unit

TABLE 6-14

Fishing and Hunting
Future Without

Texas Coastal Basins

Activity	Subareas 1/									Basin Total		
	Upper			Middle			Lower					
	Current	2000	2020	Current	2000	2020	Current	2000	2020	Current	2000	2020
Fishing												
Boat - Activity Days (X 1000)	65079	65079	65079	6521	11819	13857	13210	13210	13210	84810	90108	92146
Surface Acres	214200	214200	214200	22400	40600	47600	42120	42120	42120	273720	296920	303920
Pier 2/ Activity Days (X 1000)	407	407	407	175	175	175	81	81	81	663	663	663
Linear Yards	3100	3100	3100	1300	1300	1300	700	700	700	5100	5100	5100
Hunting												
Inland - Activity Days(X 1000)	7793	7793	7793	7312	7276	7262	4808	4808	4808	19913	19877	19863
Acres	2761500	2761500	2761500	3736700	3718500	3711500	6010000	6010000	6040000	12508200	12489000	1283000
Marsh 2/ Activity Days(X 1000)	933	933	933	506	506	506	170	170	170	1609	1609	1609
Acres	294000	294000	294000	152000	152000	152000	81000	81000	81000	527000	527000	527000

1/ These subareas were originally called coastal subunits in the Special Report on Fish and Wildlife, which comprises a larger evaluation unit.
2/ Fishing from piers, barges, and marinas and marsh hunting remain constant throughout the study period.

Source: Information compiled by River Basin Staff from data taken from Texas Outdoor Recreation Plan and data taken from the Texas Water Development Board.

providing 1.6 million activity days. However, it should be expected as new reservoirs are constructed and as the demand calls for additional resources, new facilities will be developed.

Two types of hunting are shown in this table - inland and marsh. A total of 13.2 million acres are currently available in this unit of evaluation for inland hunting. This resource provides over 19.9 million activity days. However, the only known reduction of habitat of 25,200 acres will occur in the Middle Subarea when the new reservoirs are constructed.

The 1.6 million activity days of marsh hunting is currently being provided on 527,000 acres of land. This acreage is shown to remain the same.

Erosion and Sedimentation

The erosion and sedimentation rates under present conditions were applied to the land use projection by subareas to arrive at the delivered tons from sheet erosion. The effect of existing programs was estimated for the future and applied to all categories of erosion and sedimentation.

The tons of sediment derived from sheet erosion for future without plan conditions are projected to increase about 3 percent from present levels by the year 2000 due primarily to increased forestry activities, which outweigh the effect of the on-going land treatment programs. By the year 2020 sheet erosion annual amounts will have decreased slightly but will still remain about 2 percent above present levels. All other categories of erosion and sedimentation will show a decrease from present levels by the year 2000 and a further decrease by the year 2020.

Table 6-15 shows the total annual amounts of erosion and sedimentation under without plan conditions by subarea. The average soil loss rate is well below the established tolerance for sheet erosion throughout the basin; however, some areas having steep topographic relief and improper land use are hazardous.

The total showed sediment to the bays and estuaries from impacts on all current land uses is 9,912,100 tons. Of this total, only 1.7 percent comes from forest land.

TABLE 6-15

Erosion and Sedimentation Summary
Total Amounts Without Plan Development

Texas Coastal Basins

	UPPER SUBAREA			MIDDLE SUBAREA			LOWER SUBAREA			BASIN TOTAL		
	Current	2000	2020	Current	2000	2020	Current	2000	2020	Current	2000	2020
DEL. SHEET TONS	1,307,400	1,489,200	1,447,600	2,459,300	2,552,000	2,536,600	2,903,700	2,844,700	2,800,400	6,670,400	6,885,900	6,784,600
DEL. GULLY TONS	268,200	228,000	201,200	207,200	176,100	155,400	50,900	43,300	38,200	526,300	447,400	394,800
DEL. STREAMB. TONS	785,900	736,800	705,300	308,300	289,000	276,700	92,600	86,800	83,100	1,186,800	1,112,600	1,065,100
DEL. ROADSIDE TONS	380,300	332,800	313,700	81,000	70,900	66,800	46,300	40,500	38,200	507,600	444,200	418,700
DEL. SHORELINE TONS	193,700	181,600	162,200	483,300	453,100	404,800	344,000	322,500	288,100	1,021,000	957,200	855,100
SCOUR ACRES ANNUAL	1,000	900	800	3,000	2,950	2,900	7,100	6,900	6,800	11,100	10,750	10,500
LAND LOST-GULLY AC.	25	19	16	24	18	16	19	14	12	68	51	44
LAND LOST-STREAMB. AC.	62	58	56	38	36	34	33	31	30	133	125	120
LAND LOST-SHORE. AC.	39	37	33	55	52	46	15	14	13	109	103	92
OVERBANK DEPOSITION AC.	19,400	17,000	14,100	13,100	11,500	9,500	6,900	6,000	5,000	39,400	34,500	28,600
SED TO BAYS & EST. TONS	2,991,500	3,025,000	2,883,500	19,676,800	19,593,500	19,033,100	4,491,800	4,359,900	4,242,600	27,160,100	26,978,400	26,159,200

Source: River Basin Staff, SCS

Archeological and Historical Resources

Table 6-16 shows 2,678 archeological sites and 319 historical sites are presently recorded in the basin. Due to the interest shown in recent years to the environmental impact of a project, the number of known archeological sites will increase. An additional 150 historical and 53 archeological sites are estimated to be inventoried under the future without plan by the year 2000. An additional 112 historical and 58 archeological sites are expected to be inventoried by the year 2020.

TABLE 6-16

Current and Projected Archeological and Historical Sites under Future Without Plan Conditions

Texas Coastal Basins

SUBAREAS	Historical	Archeological
UPPER		
1975	134	1,450
2000	60	20
2020	40	20
MIDDLE		
1975	150	911
2000	75	28
2020	60	28
LOWER		
1975	35	317
2000	15	5
2020	12	10
TOTAL		
1975	319	2,678
2000	150	53
2020	112	58

Source: River Basin Staff, SCS

RESOURCE DEVELOPMENT NEEDS

TEXAS COASTAL BASINS

CHAPTER 7

RESOURCE DEVELOPMENT NEEDS

INTRODUCTION

Resource development needs were determined for this study to address the basin problems identified. Study concerns were established in the Plan of Work and modified as the study progressed. These study concerns were translated into the major planning objective to which they are primarily related. Major planning objectives outlined in Chapter 3 are adjusted in this chapter, Chapter 8, and Chapter 1 to reflect procedural adjustments described in Chapter 2 and the most recent directive concerning the division of national and regional benefits. These chapters present studied information related to program opportunities implementable by the U. S. Department of Agriculture if authorization and funding is available. Specific components or elements are thus accounted for under Economic Development (ED) and Environmental Quality (EQ). The delineation between national and regional development accounts has been omitted. ED components will enhance economic development by increasing the value of goods and services and improving economic efficiency. EQ components will enhance environmental quality by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

The classification of a component or component need as ED or EQ does not preclude the use of elements of that component in planning toward either objective.

SPECIFIC DESCRIPTION FOR COMPONENT NEEDS

Economic Development

Floodwater Damage Reduction: The basin's upstream watersheds were all investigated and the total flood damages were determined for each watershed. Potential for reducing floodwater damages was determined by evaluating most watersheds with channel improvements.

Channel criteria provided for 5-year frequency agricultural protection and 100-year frequency urban protection. Structural costs and damage reduction were determined as were benefit-cost ratios which resulted in economical and uneconomical projects. This analysis provided the basis by which watershed potential was established.

One hundred and nine watersheds were identified in the basin and classified according to project status, Table 7-1. A total of 33 watersheds have the potential for project development that will provide for a program to reduce flood damages using current criteria. There are 64 watersheds infeasible under current economic criteria; however, rural and urban flood damage does exist and reduction is needed.

TABLE 7-1

Watershed Status for Flood Damage Reduction

Texas Coastal Basins

Watershed Status 1/	Subareas			Basin Total
	Upper	Middle	Lower	
Completed (SCS)	1	2	2	5
In operation (SCS)	0	1	1	2
Approved for operation (SCS)	0	0	0	0
Being planned (SCS)	0	1	0	1
Corps of Engineers Projects	3	1	0	4
Subtotal	4	5	3	12
Potential projects	3	28	2	33
No potential (currently)	26	18	20	64
Component need	3	28	2	33

1/ Expected status through the year 2000

Source: SCS

Flood problems exist on 7,296,500 acres of flood plain. About 38 percent (2,760,200 acres) of this flood plain is forest land, rangeland, and Federal land with insignificant flood damages. This land, with 73,000 acres having flood reduction projects existing or authorized, were deducted from the total, leaving 4,463,300 acres currently needing flood damage reduction. It is expected that under the on-going program four watershed projects will be completed by 2000 and another four completed by 2020, Table 7-2.

TABLE 7-2

Flood Damage Reduction Needs

Texas Coastal Basins

	SUBAREAS									Basin Total		
	Upper			Middle			Lower					
				Acres								
	1975	2000	2020	1975	2000	2020	1975	2000	2020	1975	2000	2020
Urban	282,300	282,300	282,300	62,600	56,800	51,300	51,300	51,300	51,300	396,200	390,400	384,9
Rural	1,187,000	1,187,000	1,187,000	2,602,800	2,316,000	2,087,500	277,300	277,300	277,300	4,067,100	3,780,300	3,551,8
Basin Total	1,469,300	1,469,300	1,469,300	2,665,400	2,372,800	2,138,800	328,600	328,600	328,600	4,463,300	4,170,700	3,936,7

Source: River Basin Staff, SCS

Fishing and Hunting: The additional resources or facilities needed to meet the public desires or demand in the area of concern are shown in Table 7-3. These data were derived from the differences between Chapter 5 (public desires or demand) and Chapter 6 (future without project or supply).

The proposed USDA program potential has no provision for meeting the component needs for fishing and hunting.

The surface acres of water for the basin are sufficient to meet the desires of the public for boat fishing. The Middle Subarea is the only subarea which will have a need for additional resources during this study period. However, the existing resources in the other subareas can fulfill the need.

The facilities for pier fishing are incapable of supplying this demand in any subareas. This demand must be met by a

TABLE 7-3

Fishing and Hunting Needs

Texas Coastal Basins

Activity	Subareas 1/									Basin Total		
	Upper			Middle			Lower					
	Current	2000	2020	Current	2000	2020	Current	2000	2020	Current	2000	2020
Fishing 1/ Boat - Activity Days (X 1000)	0	0	0	0	0	1875	0	0	0	0	0	0
Surface Acres	0	0	0	0	0	6564	0	0	0	0	0	0
Pier - Activity Days (X 1000)	59	2506	4167	160	909	1373	0	187	316	215	3602	5856
Linear Yards	400	19200	32084	1000	6300	9601	0	1500	2554	1400	27000	44239
Hunting 1/ Inland - Activity Days (X 1000)	0	0	0	0	0	0	0	0	365	0	0	0
Acres	0	0	0	0	0	0	0	0	448750	0	0	0
Marsh - Activity Days (X 1000)	0	0	0	0	0	22	0	11	113	0	0	0
Acres	0	0	0	0	0	43556	0	5200	53762	0	0	0

1/ These subareas were originally called coastal subunits in Special Report on Fish and Wildlife, which comprises a larger evaluation unit.

Source: Information compiled by River Basin Staff from data taken from Texas Outdoor Recreation Plan.

joint effort by all concerned units of government, as well as the private sector of the economy, or another type of fishing, such as bank or boat fishing, must be substituted.

The basins' wildlife resources for inland and marsh hunting are sufficient to meet the demand. Evaluation by coastal subareas reveals additional resources will be needed in the Lower Subarea for inland hunting by 2020. Additional resources will be needed for marsh hunting in the Middle Subarea by 2020 and in the Lower Subarea by 2000.

A need for additional hunting resources exists in some subareas for a particular type of hunting. These needs can be fulfilled by utilizing the surplus resource in other subareas.

Outdoor Recreation: The current and projected need for each selected recreational activity is displayed in Table 7-4. These needs are presented by activity days and their related facility units to aid in future planning.

The demand or public desire will exceed the resource available for each selected activity before 2020 for the basin.

TABLE 7-4

Outdoor Recreation Needs

Texas Coastal Basins

Activity	Subareas									Basin Total		
	Upper			Middle			Lower					
	Current	2000	2020	Current	2000	2020	Current	2000	2020	Current	2000	2020
Camping												
Activity Days (1000)	1305	7579	11345	494	4542	7022	1977	6919	10286	3776	19040	28653
Sites	2421	14061	21048	639	5883	9084	4462	15618	23219	7522	35562	53351
Picnicking												
Activity Days (1000)	384	19124	30160	470	7412	11657	1101	17888	22468	1955	44424	64285
Tables	286	14282	22457	468	7382	11610	801	13019	16352	1555	34683	50419
Swimming												
Activity Days (1000)	16255	123160	263924	2553	16037	29996	3728	29455	43354	22536	163652	337274
Square Yards (1000)	361	2737	5865	1134	7128	13331	27	218	321	1522	10083	19517
Golf												
Activity Days (1000)	1469	10014	20294	0	0	197	0	469	1107	1127	10379	21598
Holes	370	2524	5074	0	0	38	0	178	426	284	2657	5538
Child's Play												
Activity Days (1000)	0	21402	58790	0	0	0	0	0	0	0	15702	56918
Acres	0	879	2210	0	0	0	0	0	0	0	645	2342
Baseball/Softball												
Activity Days (1000)	0	0	334	0	0	0	209	978	1797	0	0	1791
Fields	0	0	24	0	0	0	22	105	194	0	0	218
Trails												
Activity Days (1000)	26552	294002	629900	4777	31118	57018	2763	25423	53941	34092	350543	740859
Miles	366	4319	9284	267	1440	2638	192	1846	3980	3850	7602	15902
Watersports												
Activity Days (1000)	0	5056	17780	0	569	2098	0	0	0	0	3304	18441
Surface Acres	0	6617	23272	0	1598	5893	0	0	0	0	7975	27227

Source: Information compiled by River Basin Staff from data taken from Texas Outdoor Recreation Plan.

The needs in the Upper Subarea resemble the needs in the total basin in relation to the activities which have a need in each time frame. The Middle Subarea has two activities, child's play and baseball, which have sufficient facilities to meet their demand beyond 2020, and one activity, golfing, can meet its demand past 2000. In the Lower Subarea, baseball and watersports have sufficient resources beyond 2020. All other activities have a current need with the exception of golf which can only meet its current need.

This recreational inventory includes only resources which were developed. However, it can be assumed that numerous recreational pursuits are being met from undeveloped or non-institutional resources. Since these resources were not inventoried, it is difficult to relate the actual need to be fulfilled.

Many activity occasions are currently being fulfilled from outside the basins. When the basins' boundaries were established for this study, most of the reservoirs located in Southeast Texas were omitted by this imaginary boundary. These reservoirs include Toledo Bend, Sam Rayburn, Lake

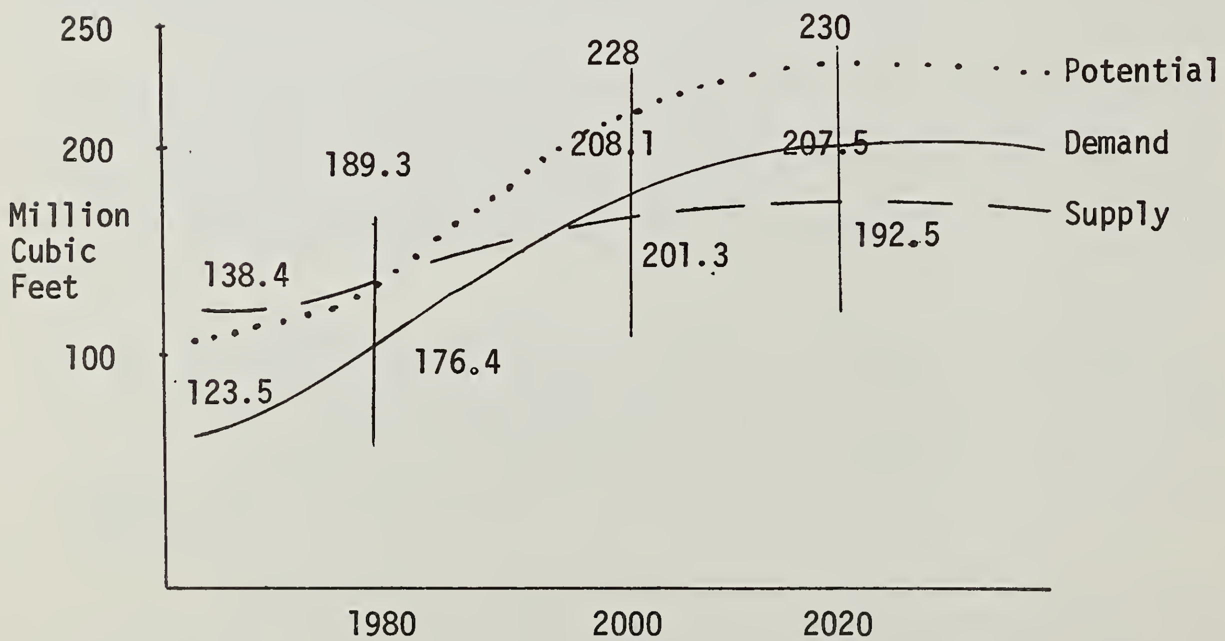
Livingston, B. A. Steinhagan, and Somerville, which comprise 404,960 surface acres of water. Recreational activities currently being provided by these sites include 29 million activity days of watersports, over one million days of camping, 71 thousand days of swimming, and probably many other recreational activities are meeting demands of the basins' residents.

Increased Timber Production: Projections of timber supply and demand in the basin indicate an increase in demand from 152 million cubic feet in 1970 to 192 million cubic feet in 2020 while the forest acreage is projected to decline from 4,435,000 acres to 3,854,000. By 2020, demand will exceed supply at an annual rate of 15 million cubic feet, assuming a continuation of present trends in management. Figure 7-1 shows that demand for roundwood will intersect and surpass supplies by about 1990.

FIGURE 7-1

Roundwood Supply/Demand Relationships 1962 - 2020

Texas Coastal Basins



Source: FS

Environmental Quality

Erosion and Sedimentation: The need for reduction in sheet erosion is moderate, about 31 percent basinwide by the year 2000 and 51 percent by the year 2020. The component needs in all other categories are more substantial, percentage-wise. The reduction need by 2020 for gully erosion is about 70 percent. The same need for streambank erosion is about 85 percent and for roadside erosion is about 77 percent. The need for scour damage reduction by 2020 is about 95 percent and for overbank deposition about 73 percent.

Archeological and Historical Resources: There is a need at present to preserve and protect 2,678 archeological sites and 319 historical sites. This need will increase by an additional 123 archeological sites by the year 2000 and 108 additional archeological sites by 2020.

Historical sites that need preservation will increase by an additional 87 sites by the year 2000 and an additional 78 sites by 2020.

The needs are for the additional sites that will be inventoried. After this inventory those sites that are significant will need to be preserved and protected. Table 7-5 shows the projected significant sites.

TABLE 7-5

Current and Projected Archeological and Historical Sites

Texas Coastal Basins

Subareas	Archeological	Historical
Upper		
1975	1,450	134
2000	10	40
2020	20	40
Middle		
1975	911	150
2000	88	37
2020	88	30
Lower		
1975	317	35
2000	25	10
2020	0	8
Total		
1975	2,678	319
2000	123	87
2020	108	78

Source: River Basin Staff, SCS

Texas has laws to protect archeological and historical sites. Coordination of historical and archeological sites identification and preservation is done at the State level. Valuable assistance is provided by local groups throughout the State as well as regional and State archeological societies. The local organizations can assist by erecting historical markers which increase public awareness, and by organizing local fund-raising efforts for site acquisition.

Emphasis was given to determining gross needs under present conditions and projected needs for 2000 and 2020 without accelerated resource development activities. Those needs that could be satisfied with existing projects and on-going programs were deducted from gross needs for 2000 and 2020. Table 7-6 summarizes the component needs.

TABLE 7-6

Specific Components and Component Needs, Present and Projected

Texas Coastal Basins

Specific Components	Component Needs	Unit 3/	UPPER Current	UPPER 2000	UPPER 2020	MIDDLE Current	MIDDLE 2000	MIDDLE 2020	LOWER Current	LOWER 2000	LOWER 2020	BASIN TOTAL Current	BASIN TOTAL 2000	BASIN TOTAL 2020
ECONOMIC DEVELOPMENT														
1. Increased Productivity of land for residential, agricultural, commercial, and industrial activities	Flood Reduction:													
	Agriculture	M Acres	1187	1187	1187	2603	2316	2088	277	277	277	4067	3780	3552
	Urban	M Acres	282	282	282	63	57	51	51	51	51	396	390	385
	Sheet erosion damage reduction	M Tons	1307	228	354	2459	898	1325	2904	1067	1732	6670	2102	3411
2. Increased output of outdoor recreation opportunities	Camping	M Activity Days	1305	7579	11345	494	4542	7022	1977	6919	10286	3776	19040	28653
	Picnicking	M Activity Days	384	19124	30160	470	7412	11657	1101	17883	22468	1955	44424	[illegible]
	Swimming	M Activity Days	16255	123160	263924	2553	16037	29996	3728	29455	43354	22536	168652	337274
	Golf	M Activity Days	1469	10014	20294	0	0	197	0	469	1107	1127	10376	21598
	Child's Play	M Activity Days	0	21402	58790	0	0	0	0	0	0	0	15702	56318
	Baseball/Softball	M Activity Days	0	0	334	0	0	0	209	978	1797	0	0	1791
	Trails	M Activity Days	26552	294002	629900	4777	31118	57018	2763	25423	53941	34092	350543	[illegible]
	Watersports	M Activity Days	0	5056	17780	0	560	2098	0	0	0	0	3304	18441
3. Increase or more efficient output of timber production	Increased timber production	M Cu. Ft.	0	15000	0	0	0	0	0	0	0	0	15000	0
4. Increased hunting & fishing opportunities	Increased pier fishing activities 1/	M Activity Days	59	2506	4167	160	909	1373	0	187	316	215	3602	5556
	Increased hunting activities 2/	M Activity Days	0	0	0	0	0	22	0	11	478	0	0	0
ENVIRONMENTAL QUALITY														
5. Improved quality aspects of water and land														
a. Improved water quality	Overbank deposition	M Acres	19	7	14	13	5	10	7	2	5	39	15	[illegible]
	Bays and estuaries	M Tons	2992	781	1388	19677	4836	9195	4492	1013	2011	27160	6639	12593
b. Reduction in non-point critical erosion	Critical erosion reduction:													
	Gully -	M Tons	268	94	188	207	72	145	51	18	36	526	184	369
		Acres	25	6	16	24	6	16	19	4	12	68	16	44
	Streambank -	M Tons	786	344	666	308	135	261	93	41	79	1187	520	1076
		Acres	62	27	56	38	17	34	33	15	30	133	59	120
	Shoreline -	M Tons	194	85	153	483	211	381	344	151	271	1021	447	805
		Acres	39	17	33	55	24	46	15	6	13	109	47	92
	Scour damage -	Acres	1000	400	800	3000	1450	2900	7100	3350	6800	11100	5200	11100
6. Preservation of archeological sites, historical sites	Protection	Number	1450	10	20	911	88	88	317	25	0	2678	123	108
		Number	134	40	40	150	37	30	35	10	8	319	87	78

1/ Sufficient water resources exist in the basin for boat fishing.
2/ A need exists in some subareas; however, this need can be met from resources in other subareas as shown in the basin totals.
3/ M=X 1000

Source: FS, ERS, SCS

CHAPTER 8

DEVELOPMENT OPPORTUNITIES AND IMPACTS

TEXAS COASTAL BASINS

CHAPTER 8

DEVELOPMENT OPPORTUNITIES AND IMPACTS

USDA PROGRAM OPPORTUNITIES

The study concerns as identified previously for each of the objectives provide the basis for USDA program opportunities. Specific components for the objectives were identified from the study concerns. The sponsors provided input for the study concerns and the specific components of the objectives. The kinds of preferred outputs desired as a result of the study are also presented.

Emphasis was also placed on identifying USDA programs that have a potential for reducing flood damages as well as erosion damages and the resulting damages caused by sediments.

Evaluations were also made that concern the preservation of unique areas, archeological sites, and historical sites.

Projections presented in previous chapters are a manifestation of the study concerns of basin residents and sponsors of the study. The USDA program opportunities provide elements that meet part of the component needs. The effectiveness of the realization of the USDA program potentials within the basin is measured by the number of needs met.

The USDA program opportunities provide a means for the solution of some of the major water and related land problems of the basin.

Opportunities for resource development in the basin include both land treatment and structural measures for reducing economic losses due to floods, inadequate drainage, soil loss, sedimentation, land loss, and pollution. These measures are designed to provide better economic opportunities by enhancing both the quantity and quality of recreation, fish and wildlife habitat, changed land use, increased crop yields, increased wood production, and improvement of the environment. Although other programs and needs were identified, programs of local, State, and other Federal agencies should be considered.

USDA PROGRAM ELEMENTS

Resource Management Systems

Essential elements of an effective land and water management system include land treatment measures and management systems. The installation of an effective land treatment and management system program is basic for the development of water and related land resources.

Resource management systems may include crop residue management, cover crops, terraces, grassed waterways, contour farming, grass in rotation with crops, or permanent grass cover.

For each land use there is a combination of conservation practices and management which will protect the resource base and improve the standard of living with minimal adverse effect on the environment. The proper combination depends upon the objectives of the landowner, climate, topography, soils, and condition of the landscape. Any combination contains the essential practices necessary to adequately treat the land.

Future installation of resource management systems is projected at two alternatives as shown in Figure 8-1. Based on historical data and agency experience with the present on-going programs, 60 percent of the land could attain the adequately treated status by 2020. The second alternative assumes a realistic goal of 80 percent of the land to be adequately treated by 2020 if monetary incentives are available. It would be difficult to obtain a higher degree because of ownership change, areas infeasible to treat, and the reluctance of some people to install conservation measures. The shaded area denotes the amount of land which could be adequately treated with installation of resource management systems at an accelerated rate.

Table 8-1 shows about one million acres of cropland would be adequately treated if the opportunity for acceleration of the application of resource management systems becomes a reality. More than 1.4 million acres of rangeland would be improved and protected.

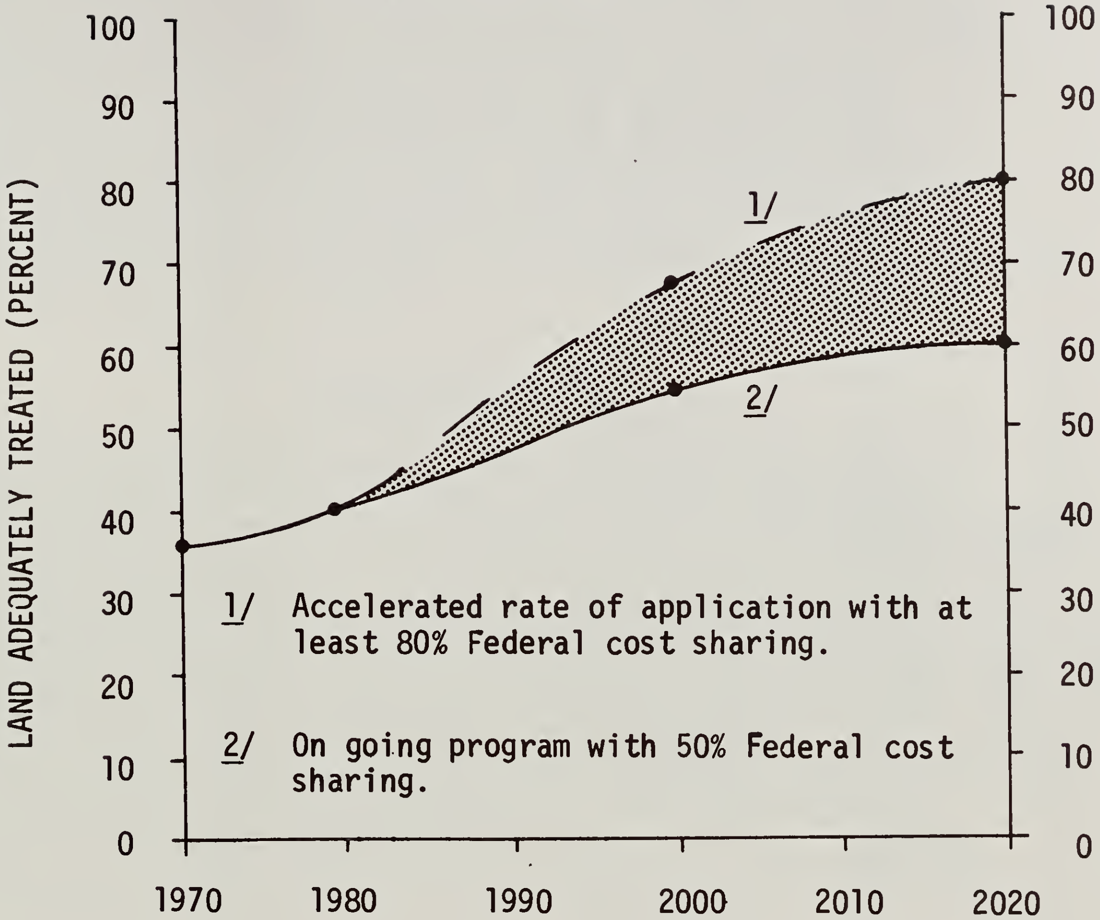
It was assumed that sediment reduction is directly proportional to erosion reduction and that erosion cannot be totally eliminated.

Opportunities to reduce sediment load are closely tied to conservation measures for erosion control. These measures

FIGURE 8-1

Future Land Treatment

Texas Coastal Basins



Source: River Basin Staff, SCS

include conservation land treatment on cropland, pastureland, forest land, and other non-point sediment source areas. The combined effects of all measures, should they be installed by 2020, will reduce sedimentation by 177,400 tons per year. No debris basins or other reservoirs having sediment entrapment as a primary purpose are included as program opportunity elements.

Most of the land treatment measures result in erosion damage reduction and protection of the land base with the accompanying increase in soil productivity and management efficiency.

Elements within USDA program opportunities could annually reduce sheet erosion by 177,400 tons, scour damage on 450 acres, and sediment damage on 700 acres of flood plain by the year 2020.

TABLE 8-1

Components and Elements of USDA Programs Opportunities

Texas Coastal Basins

Component and Elements	Unit	Element Quantities Upper 2000	Upper 2020	Middle 2000	Middle 2020	Lower 2000	Lower 2020	Total 2000	Total 2020
Resource Management Systems									
Cropland	Acres	206,000	127,000	419,000	426,000	313,000	359,000	938,000	912,000
Pastureland	Acres	254,000	319,000	52,000	42,000	10,000	39,000	316,000	400,000
Rangeland	Acres	19,000	46,000	181,000	194,000	796,000	1,239,000	996,000	1,479,000
Other Land	Acres	2,000	1,000	22,000	30,000	0	17,000	24,000	40,000
Increased Timber Production									
Accelerated Forest Management	Million Cu. Ft/Yr	5.0	0	0	0	0	0	5.0	0
Forest Utilization	MCF/Yr	10.0	0	0	0	0	0	10.0	0
Recreation 1/	Thousand Activity Days	239	0	0	0	0	0	239	0

1/ Based on National Forest Unit Plan

Source: River Basin Staff, SCS

Flood Damage Reduction

Structural measures to reduce flood damages include floodwater retarding structures and channel modification. USDA program opportunities within 31 watersheds in the basin include the installation of 2283.7 miles of channel modification. This would be about 5.7 percent of the total basin needs of 39862.3 miles. Program opportunities also include the installation of 14 floodwater retarding structures in two additional watersheds by 2000. These measures will benefit 1,966,800 acres or 46 percent of the total area of the 33 watersheds. Table 8-2 shows the recommended structural measures by watersheds and subareas.

Outdoor Recreation

The Texas Outdoor Recreation Plan recommends that the Forest Service supply a certain number of the rural recreation facilities for recreation in region number 26 (Walker, Montgomery and Liberty counties). If funds are available for all recreation construction in the Forest Service's Conroe Unit Plan, the Conroe Unit will provide 57 percent of the campsites, 27 percent of the picnic sites, 50 percent of the boat ramps, and 100 percent of the trails allocated to the Forest Service within that region, Table 8-1. Even though this will fulfill only a small increment of the total recreation needs, it is an opportunity to provide measures to meet the needs for additional recreation facilities. Remaining facilities needs can be met through RC&D on-going programs and other programs or sources.

Forest Production

The 2020 program opportunities will provide the additional 15 million cubic feet needed by 2020 to bring production to 208 million cubic feet, Table 8-1. Improved utilization measures will provide 65 percent of the increased volume, or about 10 million cubic feet of roundwood. This increase can be achieved by improved manufacturing and harvesting methods as well as proper use of equipment and felling and bucking techniques.

Accelerated forest management will provide the remaining 35 percent of the needs. This measure includes reforesting 40,000 acres, improved cutting on 280,000 acres, regenerating 2,700 acres per year and timber stand improvement on 19,000 acres per year.

ENVIRONMENTAL CONSIDERATIONS

Development exerts either beneficial or adverse effects on the basin's environment. Structural measures to reduce flood damages probably have the most adverse effects. Generally, the conservation management systems have less adverse effects with most being beneficial.

Consideration of the environment was of importance in selecting the elements of USDA programs which have development opportunities within the basin. Projects should have minimum detrimental effects and, when possible, should enhance the environment. The effects and changes that will result from project construction must be recognized and identified to assist in deciding how to plan, design, install, and maintain a project.

Environmental features that should be identified include effects on natural and scenic areas; ecological and biological resources; the quality of water, land, and air; and any irreversible and irretrievable commitment of resources. Techniques and measures to protect and enhance the environment should be included in the design, installation, and maintenance of structural measures. Design measures such as protection of special features, placement of spoil, specifications for vegetation, and inclusion of landscape items add to environmental quality. The effects of construction can be minimized by special techniques. Maintenance should include measures that are complementary with environmental features.

LEGAL AND INSTITUTIONAL ASPECTS

The USDA program opportunities can be implemented by Federal and State agencies presently in existence in many areas of the basin. However, the acceleration and expansion of programs to some parts of the basin require that local sponsors be organized under present authorities. Where the programs are to be planned and installed under the Watershed Protection and Flood Prevention Act (Public Law 83-566), a local or State sponsor must meet certain legal requirements before these projects can be initiated. Further expansion of the present Resource Conservation and Development (RC&D) Projects to include additional areas under the Food and Agriculture Act (Public Law 87-703) would be a means to implement some program elements.

Table 8-2

Recommended Structural Measures, Average Annual Costs, and Average Annual Benefits

Texas Coastal Basins

Watershed Number	Watershed Name	Channel Modification (Miles)	Floodwater Retarding Structures Number	Average Annual ED Costs 1/ Project Installation $	Project Administration $	Operation and Maintenance $	Total ED $	Average Annual EQ Costs 1/ Project Installation $	Project Administration $	Operation and Maintenance $	Total EQ $	Total Average Annual ED and EQ Costs 1/ Project Installation $	Project Administration $	Operation and Maintenance $	Grand Total $	Average Annual Benefits 2/ Floodwater Damage Reduction $	Agricultural Water Management $	Total $	ED Benefit-Cost Ratio	Overall Benefit Cost Ratio
	UPPER SUBAREA																			
94	Old River	44.9	0	278700	13700	58600	351000	43500	1000	6100	50600	322200	14700	64700	401600	241300	241300	482600	1.4:1.0	1.2:1.0
98	Turtle Bayou	92.9	0	363700	34900	101500	500100	39900	2000	12200	54100	403600	36900	113700	554200	484800	484800	969600	1.9:1.0	1.7:1.0
99	Spindletop Bayou & Others	162.5	0	583200	56800	227900	867900	149500	7400	42900	199800	732700	64200	270800	1067700	623900	623900	1247800	1.4:1.0	1.2:1.0
	Subarea Total	300.3	0	1225600	105400	388000	1719000	232300	10400	61200	304500	1458500	115800	449200	2023500	1350000	1350000	2700000		
	MIDDLE SUBAREA																			
32	Seadrift - West Coloma	26.6	0	223800	16200	30000	270000	21300	800	4300	26400	245100	17000	34300	296400	252000	252000	504000	1.9:1.0	1.7:1.0
33	Indianola	19.2	0	122900	7300	28700	158900	18300	700	3300	22300	141200	.8000	32000	181200	293700	293700	507400	3.7:1.0	3.2:1.0
34	Garcitas Creek	28.7	0	119100	8300	35300	162700	21500	900	4900	27300	140600	9200	40200	190000	335100	335100	670200	4.1:1.0	3.5:1.0
35	Placedo Creek	62.7	0	285200	20200	70300	375700	41100	1900	9600	52600	326300	22100	79900	428300	417700	417700	835400	2.2:1.0	2.0:1.0
36	Arenosa Creek	16.9	0	153900	10900	43600	208400	18500	500	2500	21500	172400	11400	46100	229900	394000	394000	708000	3.8:1.0	3.4:1.0
39	Lower Lavaca River	35.5	0	153600	11400	57700	222700	14000	400	6900	21300	167600	11800	64600	244000	501500	501500	1003000	4.5:1.0	4.1:1.0
41	Lower Navidad River	49.0	0	135400	10200	56800	202400	19900	600	4300	24800	155300	10800	61100	227200	291800	291800	583600	2.9:1.0	2.6:1.0
42	Sandy Creek	32.2	0	180600	13600	46100	240300	44000	1800	9100	54900	224600	15400	55200	295200	311000	311000	622000	2.6:1.0	2.2:1.0
44	Mustang Creek	120.4	0	770200	51400	162100	983700	127600	5800	25200	158600	897800	57200	187300	1142300	1353300	1353300	2706600	2.8:1.0	2.4:1.0
45	Pin Oak Creek	60.9	0	305100	23700	64200	393000	41500	2000	10100	53600	346600	25700	74300	446600	486300	486300	972600	2.5:1.0	2.2:1.0
46	Cox's and Keller's Creeks	37.1	0	73100	5500	43200	121800	22900	4600	7000	34500	96000	10100	50200	156300	184600	184600	369200	3.0:1.0	2.4:1.0
47	Carancahua Creek	75.0	0	450800	31900	137400	620100	94400	4600	20200	119200	545200	36500	157600	739300	1599300	1599300	3198600	5.2:1.0	4.3:1.0
48	Turtle Creek	18.9	0	07500	5700	20200	108400	21300	1000	4100	26400	140600	9200	40200	190000	190300	190300	380600	3.5:1.0	2.8:1.0
49	Tres Palacios	275.8	0	1059400	125200	216500	1401100	140000	8000	45400	193400	1199400	133200	261900	1594500	1525700	1525700	3051400	2.2:1.0	1.9:1.0
50	West Tribs of the Colorado River	83.3	0	466000	34400	94900	595300	34700	1200	9100	45000	500700	35600	104000	640300	578700	578700	1157400	1.9:1.0	1.8:1.0
51	Jones Creek	65.5	0	198600	11800	64200	274600	43300	1900	9500	54700	241900	13700	73700	329300	194300	194300	388600	1.4:1.0	1.2:1.0
52	Blue Creek	61.3	0	204400	13800	52900	271100	12900	2300	10300	25500	217300	16100	63200	296600	278800	278800	557600	2.1:1.0	1.9:1.0
53	East Tribs of the Colorado River	68.6	0	300200	17400	68000	385600	59300	2000	10400	72300	360100	19400	78400	457900	503000	503000	1006000	2.6:1.0	2.0:1.0
56	West Tribs of the San Bernard River	238.4	0	878900	32500	223900	1135300	185700	10100	42900	238700	1064600	42600	266800	1374000	1359800	1359300	2719600	2.4:1.0	2.0:1.0
58	Caney Creek (Wharton & Matagorda Co.)	150.4	0	708100	65900	116100	890100	195800	10600	41300	247700	903900	76500	157400	1137800	561100	561100	1122200	1.3:1.0	1.0:1.0
59	Live Oak Bayou	24.7	0	86800	3400	23900	114100	27700	1400	5700	34800	114500	4800	29600	148900	91700	91700	183400	1.6:1.0	1.5:1.0
60	East Tribs of the San Bernard River	47.4	0	98100	5900	36600	140600	21100	600	4800	26500	119200	6500	41400	167100	225600	225600	451200	3.2:1.0	2.7:1.0
62	Mound Creek	31.1	0	55400	6000	24000	85400	28400	800	6700	35900	03800	6800	30700	121300	103000	103000	206000	2.4:1.0	1.7:1.0
65	New Years Creek	0	8	181100	6700	3200	191000	-	-	-	-	181100	6700	3200	191000	254000	-	254000	1.3:1.0	1.3:1.0
66	Caney Creek (Austin & Washington Co.)	0	6	61100	3300	2100	66500	-	-	-	-	61100	3300	2100	66500	88300	-	88300	1.3:1.0	1.3:1.0
71	Cow Creek	27.3	0	101500	7900	33600	148000	22000	1100	5100	28200	123500	9000	43700	176200	104500	104500	209000	1.4:1.0	1.2:1.0
72	Varner Creek	18.8	0	60300	5100	14500	79900	13600	600	3200	17400	73900	5700	17700	97300	203700	203700	407400	5.1:1.0	4.2:1.0
75	Bessie's and Iron's Creeks	57.9	0	369500	23500	59300	452300	46700	1500	8000	56200	416200	25000	67300	508500	393900	393900	787800	1.7:1.0	1.5:1.0
	Subarea Total	1733.6	14	7885600	579100	1834300	10299000	1338100	67700	313900	1719700	9260500	649300	2164100	12073900	13076700	12734400	25811100		
	LOWER SUBAREA																			
17	San Patricio	72.1	0	116600	8800	17800	143200	22600	1100	6800	30500	139200	9900	24600	173700	113300	113300	226600	1.6:1.0	1.3:1.0
20	Chiltipin Creek	177.7	0	640900	48300	151300	840500	113500	5700	18800	138000	754400	54000	170100	978500	931000	931000	1862000	2.2:1.0	1.9:1.0
	Subarea Total	249.8	0	757500	57100	169100	983700	136100	6800	25600	168500	893600	63900	194700	1152200	1044300	1044300	2088600		
	BASIN TOTAL	2283.7	14	9868700	741600	2391400	13001700	1707100	84900	400700	2192700	11612600	829000	2808000	15249600	15471000	15128700	30599700		

1/ 1975 price base - Amortized @ 6.375 percent, 50 years for channels, 100 years for floodwater retarding structures. Operation and maintenance at current normalized prices, Water Resources Council, November 1975.

2/ Current normalized prices, Water Resources Council, November 1975.

Source: River Basin Staff, SCS

Table 8-2

Recommended Structural Measures, Average Annual Costs, and Average Annual Benefits

Texas Coastal Basins

Watershed Number	Watershed Name	Channel Modification (Miles)	Floodwater Retarding Structures Number	Average Annual ED Costs 1/ Project Installation $	Project Administration $	Operation and Maintenance $	Total ED $	Average Annual EQ Costs 1/ Project Installation $	Project Administration $	Operation and Maintenance $	Total EQ $	Total Average Annual ED and EQ Costs 1/ Project Installation $	Project Administration $	Operation and Maintenance $	Grand Total $	Average Annual Benefits 2/ Floodwater Damage Reduction $	Agricultural Water Management $	Total $	ED Benefit-Cost Ratio	Overall Benefit Cost Ratio
	UPPER SUBAREA																			
94	Old River	44.9	0	278700	13700	58600	351000	43500	1000	6100	50600	322200	14700	64700	401600	241300	241300	482600	1.4:1.0	1.2:1.0
98	Turtle Bayou	92.9	0	363700	34900	101500	500100	39900	2000	12200	54100	403600	36900	113700	554200	484300	484800	969600	1.9:1.0	1.7:1.0
99	Spindletop Bayou & Others	162.5	0	583200	56800	227900	867900	149500	7400	42900	199800	732700	64200	270800	1067700	623900	623900	1247800	1.4:1.0	1.2:1.0
	Subarea Total	300.3	0	1225600	105400	388000	1719000	232000	10400	61200	304500	1458500	115800	449200	2023500	1350000	1350000	2700000		
	MIDDLE SUBAREA																			
32	Seadrift - West Coloma	26.6	0	223800	16200	30000	270000	21300	800	4300	26400	245100	17000	34300	296400	252000	252000	504000	1.9:1.0	1.7:1.0
33	Indianola	19.2	0	122900	7300	28700	158900	18300	700	3300	22300	141200	8000	32000	181200	293700	293700	507400	3.7:1.0	3.2:1.0
34	Garcitas Creek	28.7	0	119100	8300	35300	162700	21500	900	4900	27300	140600	9200	40200	190000	335100	335100	670200	4.1:1.0	3.5:1.0
35	Placedo Creek	62.7	0	285200	20200	70300	375700	41100	1900	9600	52600	326300	22100	79900	428300	417700	417700	835400	2.2:1.0	2.0:1.0
36	Arenosa Creek	16.9	0	153900	10900	43600	208400	18500	500	2500	21500	172400	11400	46100	229900	394000	394000	738000	3.8:1.0	3.4:1.0
39	Lower Lavaca River	35.5	0	153600	11400	57700	222700	14000	400	6900	21300	167600	11800	64600	244000	501500	501500	1003000	4.5:1.0	4.1:1.0
41	Lower Navidad River	49.0	0	135400	10200	56800	202400	19900	600	4300	24800	155300	10000	61100	227200	291000	291800	583600	2.9:1.0	2.6:1.0
42	Sandy Creek	32.2	0	180600	13600	46100	240300	44000	1800	9100	54900	224600	15400	55200	295200	311000	311000	622000	2.6:1.0	2.2:1.0
44	Mustang Creek	120.4	0	770200	51400	162100	983700	127600	5800	25200	158600	897800	57200	187300	1142300	1353300	1353300	2706600	2.6:1.0	2.4:1.0
45	Pin Oak Creek	60.9	0	305100	23700	64200	393000	41500	2000	10100	53600	346600	25700	74300	446600	406300	486300	972600	2.5:1.0	2.2:1.0
46	Cox's and Keller's Creeks	37.1	0	73100	5500	43200	121800	22900	4600	7000	34500	96000	10100	50200	156300	184600	184600	369200	3.0:1.0	2.4:1.0
47	Carancahua Creek	75.0	0	450800	31900	137400	620100	94400	4600	20200	119200	545200	36500	157600	739300	1599300	1599300	3198600	5.2:1.0	4.3:1.0
48	Turtle Creek	18.9	0	07500	5700	20200	108400	21300	1000	4100	26400	140600	9200	40200	190000	190300	190300	380600	3.5:1.0	2.8:1.0
49	Tres Palacios	275.8	0	1059400	125200	216500	1401100	140000	8000	45400	193400	1199400	133200	261900	1594500	1525700	1525700	3051400	2.2:1.0	1.9:1.0
50	West Tribs of the Colorado River	83.3	0	466000	34400	94900	595300	34700	1200	9100	45000	500700	35600	104000	640300	578700	578700	1157400	1.9:1.0	1.8:1.0
51	Jones Creek	65.5	0	198600	11800	64200	274600	43300	1900	9500	54700	241900	13700	73700	329300	194300	194300	388600	1.4:1.0	1.2:1.0
52	Blue Creek	61.3	0	204400	13000	52900	271100	12900	2300	10300	25500	217300	16100	63200	296600	278800	278800	557600	2.1:1.0	1.9:1.0
53	East Tribs of the Colorado River	68.6	0	300200	17400	68000	385600	59300	2000	10400	72300	360100	19400	78400	457900	503000	503000	1006000	2.6:1.0	2.0:1.0
56	West Tribs of the San Bernard River	238.4	0	878900	32500	223900	1135300	185700	10100	42900	238700	1064600	42600	266800	1374000	1359800	1359300	2719600	2.4:1.0	2.0:1.0
58	Caney Creek (Wharton & Matagorda Co.)	150.4	0	703100	65900	116100	890100	195800	10600	41300	247700	903900	76500	157400	1137800	561100	561100	1122200	1.3:1.0	1.0:1.0
59	Live Oak Bayou	24.7	0	86300	3400	23900	114100	27700	1400	5700	34800	114500	4800	29600	148900	91700	91700	183400	1.6:1.0	1.5:1.0
60	East Tribs of the San Bernard River	47.4	0	98100	5900	36600	140600	21100	600	4800	26500	119200	6500	41400	167100	225600	225600	451200	3.2:1.0	2.7:1.0
62	Mound Creek	31.1	0	55400	6000	24000	85400	20400	800	6700	35900	03800	6300	30700	121300	103000	103000	206000	2.4:1.0	1.7:1.0
65	New Years Creek	0	0	181100	6700	3200	191000	-	-	-	-	181100	6700	3200	191000	254000	-	254000	1.3:1.0	1.3:1.0
66	Caney Creek (Austin & Washington Co.)	0	6	61100	3300	2100	66500	-	-	-	-	61100	3300	2100	66500	88300	-	88300	1.3:1.0	1.3:1.0
71	Cow Creek	27.3	0	101500	7900	33600	148900	22000	1100	5100	28200	123500	9000	43700	176200	104500	104500	209000	1.4:1.0	1.2:1.0
72	Varner Creek	18.8	0	60300	5100	14500	79900	13600	600	3200	17400	73900	5700	17700	97300	203700	203700	407400	5.1:1.0	4.2:1.0
75	Bessie's and Iron's Creeks	57.9	0	369500	23500	59300	452300	46700	1500	8000	56200	416200	25000	67300	508500	393900	393900	787800	1.7:1.0	1.5:1.0
	Subarea Total	1733.6	14	7885600	579100	1834300	10299000	1338100	67700	313900	1719700	9260500	649300	2164100	12073900	13076700	12734400	25811100		
	LOWER SUBAREA																			
17	San Patricio	72.1	0	116600	8800	17800	143200	22600	1100	6800	30500	139200	9900	24600	173700	113300	113300	226600	1.6:1.0	1.3:1.0
20	Chiltipin Creek	177.7	0	640900	48300	151300	840500	113500	5700	18800	138000	754400	54000	170100	978500	931000	931000	1862000	2.2:1.0	1.9:1.0
	Subarea Total	249.8	0	757500	57100	169100	983700	136100	6800	25600	168500	893600	63900	194700	1152200	1044300	1044300	2088600		
	BASIN TOTAL	2283.7	14	9868700	741600	2391400	13001700	1707100	84900	400700	2192700	11612600	829000	2808000	15249600	15471000	15128700	30599700		

1/ 1975 price base - Amortized @ 6.375 percent, 50 years for channels, 100 years for floodwater retarding structures. Operation and maintenance at current normalized prices, Water Resources Council, November 1975.

2/ Current normalized prices, Water Resources Council, November 1975.

Source: River Basin Staff, SCS

Most of the basin is organized in soil and water conservation districts. The districts are eligible for assistance under the Soil Conservation Service Establishing Act (Public Law 74-46). However, to implement USDA program elements, the resource management systems on cropland, pastureland, forest land, rangeland, and other lands may require acceleration of funds and technical assistance, tax relief, and stabilization of rural income. Cost-sharing that extends beyond the present programs of technical assistance, and conservation measures is needed. Some of these are established or can be established in the counties under programs of the Agricultural Stabilization and Conservation Service (ASCS). In any event, a basinwide program to implement the elements for land treatment is needed.

COST AND BENEFITS

Costs to implement the USDA program opportunities as shown in Table 8-2 are based on installation of the structural measures by year 2000; those not installed by 2020 will be reevaluated. Project installation costs were computed for Economic Development and Environmental Quality.

Average annual costs, including operation and maintenance, are shown, as well as average annual benefits. Total installation costs, as well as annual costs, are shown for installing resource management systems, although benefits for these measures are not calculated. Average annual benefits are confined to floodwater damage reduction and improved agricultural water management.

Construction costs for structural measures are based on 1975 prices, and benefits are based on 1975 current normalized prices.

The average annual cost for the structural measures included in the USDA program opportunities amounts to $15,249,600 which would produce average annual primary benefits of $30,599,700. This would result in an overall benefit-cost ratio of 2.0:1.0.

Total installation costs, as well as annual costs, are shown in Table 8-3 for installing resource management systems. Although benefits were not computed, it is assumed that benefits will equal costs.

By 2000, an additional 15 million cubic feet of wood products each year will be put in the market through improved

TABLE 8-3

USDA Program Opportunities Cost and Benefits

Texas Coastal Basins

Component	2000			2020		
	Total Installation Cost 1/	Average Cost	Annual Benefits	Total Installation Cost 1/	Average Cost	Annual Benefits
	(Dollars)					
Resource Management Systems						
Upper Subarea	5,904,000	295,200	Not Evaluated	6,082,000	304,100	Not Evaluated
Middle Subarea	15,743,000	787,100	Not Evaluated	15,743,000	787,100	Not Evaluated
Lower Subarea	27,466,000	1,373,300	Not Evaluated	42,126,000	2,106,300	Not Evaluated
Subtotal	49,113,000	2,455,600		63,951,000	3,197,500	
Increased Timber Production						
Utilization & Accelerated Management						
Upper Subarea	15,560,000	118,000	270,000	0	0	0
Recreation						
Upper Subarea	4,000,000	100,000	1,200,000	0	0	0
TOTAL	248,735,500	2,673,600	-	63,951,000	3,197,500	-

1/ 1975 Prices

Source: River Basin Staff, SCS

utilization and accelerated management. During a 15 year period, 1985-2000, a proposed average annual cost of $118,000 will return $270,000 annually, resulting in a benefit-cost ratio of 2.3:1.0. The proposed program does not claim sole responsibility for these benefits, recognizing research and technology preempting such improvements must be recognized as co-contributors.

IMPACTS

General Environment

Installation of most plan elements will contribute to the overall improvement of environmental quality within the basin. Although losses will occur to certain types of natural habitat for wildlife, the result will be a general improvement in the environment for basin residents.

Beneficial impacts from applied conservation practices will accrue on 9.6 million acres by 2000. Adverse impacts will affect 78,000 acres of right-of-way along both main and lateral channels to be modified.

Flooding, erosion, and sediment damages will be reduces. Revegetation with multi-purpose plants, installation of terraces, woodland stand improvement, and other conservation practices will help improve the aesthetic quality of the landscape. Large trees, which have aesthetic quality, occurring in the disturbed area would be left.

Water quality will be improved by the combined results of all practices which hold soil in place and reduce pollution.

Archeological and historical sites will be identified and preserved. Impetus is expected to be generated to guarantee the preservation of these areas and enhance the basin's environmental appeal.

The impacts on wildlife and fish habitat should be minimized so that quality of the natural environment will be pleasing to basin residents. The judicious implementation of USDA program opportunities within the basin should result in an environment in which both wildlife and human residents of the basin can live in harmony.

During detailed planning, the implementing Federal and/or State agencies should re-examine each water resource development project and make appropriate modifications to minimize and mitigate adverse impacts on the environment. This should include consideration of all resource values necessary for the orderly development of water and related land resources.

If the USDA program opportunities are not realized, anticipated economic and environmental benefits will be foregone. An increase is expected in erosion rates, sedimentation, flood problems, and continued encroachment on ecologically sensitive areas without positive resource planning.

Recreation

Improved and expanded recreation facilities could result if program opportunities were realized. Programs of local, State, and other Federal agencies could provide the needed outdoor recreational facilities. Providing recreation facilities in deficit areas will have a significant impact on the social well-being of basin residents.

One of the most beneficial impacts of developing two large recreational areas in the national forest is that the dispersed camping will be concentrated in areas where routine garbage pick-up, sanitation and law enforcement will be accomplished. The already existing lake will provide safer, designated swimming sites rather than at all points on the lake. Developed recreational areas will provide safer drinking water and will reduce the risk of wildfire. Construction of facilities will harmonize with the natural environment of the area. Feeder roads in the area will be minimized.

The most detrimental effect of developing recreational areas will be the short period of time when soil is exposed from shaping and grading, which will be kept to a minimum. Quick mulching and establishment of a vegetation cover can lessen these effects.

Fish and Wildlife

The implementation of the USDA program opportunities would have both beneficial and detrimental effects on the biological ecosystems. These elements shown as program opportunities include construction of 14 flood retarding structures and 2283.7 miles of stream channel improvement, Table 8-2.

Sediment pools of the 14 floodwater retarding structures should provide nearly 1,100 surface acres of water which could provide a new fishery resource and additional habitat for avian and terrestrial species associated with an aquatic environment. These structures should also protect 13,600 acres of terrestrial habitat from flooding.

Accelerated land treatment measures, required with the installation of these projects, should enhance the quality of the existing habitat and reduce the sediment pollution from these areas.

The construction of these structures would inundate 1,100 acres of terrestrial habitat as well as disturbing an additional 311 acres for dams and spillways.

The 2283.7 miles of channel improvement (which includes only mains) would destroy or alter 52,350 acres of stream right-of-way which is expected to affect fish and wildlife. The stream right-of-way includes 7,276 acres of existing stream bed and 45,074 acres of streambank vegetation which would be affected. The 25,650 acres of right-of-way required for lateral channels is expected to have no significant effect upon either fish or wildlife. There are approximately 38,000 acres of stream right-of-way located in wooded areas and 7,000 acres located in non-woody areas. These acreages are shown in Table 8-4 by watershed.

The 2283.7 miles of main channel improvement is shown in Table 8-4 as to the type of stream it would affect. Streams were classified as either perennial, intermittent or ephemeral, and as to whether it is a natural stream unaltered by man, a manmade stream, or a natural stream previously altered by man.

Alteration of these streams would have adverse effects on both aquatic and terrestrial species indigenous to certain areas.

The aquatic environment would be affected by higher water temperatures and reduced food source (detritus) with the removal of streambank vegetation. The dredging and channel alignment would destroy the bottom habitat, cause the loss of meanders and pools along the water course, and increase the laminar flow. The rapid removal of floodwater from the flood plain by these channels would result in the loss of feeding grounds for aquatic and terrestrial organisms as well as the loss of valuable habitat for migrating waterfowl.

TABLE 8-4

Impacts on Existing Resources and
EQ Structures from Project Implementation

Texas Coastal Basins

Subarea	Watershed	Type of Stream Affected (miles): Total	Natural: P[1/]	Natural: I[1/]	Natural: E[1/]	Man Made: P	Man Made: I	Man Made: E	Natural Streams Previously Altered by Man: P	Natural Streams Previously Altered by Man: I	Natural Streams Previously Altered by Man: E	Total Acres of Streams Disturbed	Floodwater Retarding Structures (surface acres)	EQ Structures Pools (Nos)	Riparian Vegetation (acres): Disturbed Vegetation: Total	Disturbed Vegetation: Vegetation Type: Woody	Disturbed Vegetation: Vegetation Type: Non-Woody	Revegetation: Multipurpose	Revegetation: Single Purpose (sideslopes)	Converted to Stream Channel	Affected Wetlands: Type	Affected Wetlands: Acres	Affected Wetlands: EQ Structures Water Control Gates
Upper	Old River	44.9	1.8		4.9		21.4	14.6		2.2		76			603	603		402	81	120			
	Turtle Bayou	92.9	15.8	26.6	5.2		.8	18	9.5	17		89		3	1743	1743		1063	159	521			
	Spindle Top Bayou and others	162.5			.8	47.4	11		85.9	17.4		618		10	3437	1700	1737	2441	417	579	XII	109	36 flap: 16 2-way
	SUBTOTAL	300.3	17.6	26.6	10.3	47.4	33.2	32.6	95.4	36.5		783		13	5783	4046	1737	3906	657	1220		109	36 flap; 16 2-way
Middle	Seadrift - West Coloma	26.6			3.1			1.0			22.5	143			651	391	260	493	58	100			
	Indianola	19.2			5.3			9.2			4.7	58			295	251	44	190	44	61			
	Garcitas Creek	28.7		11.1	1.9		1.3			13.3	1.1	103			440	440		322	65	53			
	Placedo Creek	62.7	9.4		11.6		1.6	1.2		18.3	20.6	242		1	1223	1162	61	897	127	199			
	Arenosa Creek	16.9			9.1			1.5			6.3	21			211	211		134	33	44			
	Lower Lavaca River	35.5	1.8					12.3	18.5		2.9	99		10	501	471	30	334	78	89			
	Lower Navidad River	49			29			16.8			3.2	55			343	343		228	58	57			
	Sandy Creek	32.2	8.0	9.1	15.1							143			949	949		655	121	173			
	Mustang Creek	120.4	6.1	14.4	23.6			1.7	24	26.2	24.4	572		12	2553	2553		1677	320	356			
	Pinoak Creek	60.9	5.9	32.6	22.4							153			1274	1274		867	135	272			
	Cox's and Keller	37.1						5			32.1	136			670	570	100	478	93	99			
	Carancahua	75.0	6.8	.9	3		.4		8.7	15.1	40.1	438		12	1693	1608	85	1261	254	178			
	Turtle Creek	18.9	.9							12.1	5.9	52			322	303	19	214	54	54			
	Tres Palacios	275.8	8.3	5.4	77.2			25.1	30.4	42.8	86.6	51		13	6127	4902	1225	3756	577	1794	XIII	4	two 2-way
	W. Tribs of Colorado River	83.3	1.1	25.1	49.2			4.3		1.6	2.0	116			1964	1964		1311	121	532			
	Jones Creek (Wharton)	65.5		2.8	7.5			2.3	17.4	14.3	21.2	215		2	762	762		574	124	64			
	Blue Creek	61.3	4.9	4.5	5.5	.2	.6	4.5	10.6	17	13.5	167		4	932	932		650	132	150			
	E. Tribs of Colorado River	68.6	.4	14.1	32.7				3.1	6.6	11.7	136			931	931		625	138	168			
	W. Tribs of San Bernard	238.4	46.3	66.8	52.8			3.3	3.8	46.3	19.1	1009		10	4341	4341		3216	559	566			
	Caney Creek (Wharton and Matagorda)	150.4	10	79.5	8.8				7.1	12.2	32.8	1269		3	4511	4511		3510	547	454			
	Live Oak Bayou	24.7	3.4	2	10.1				1.1	8.1		56		2	429	429		278	72	79	XII	1	one 2-way
	E. Tribs of San Bernard	47.4	1.4	15					1.4	29.6		111			519	488	31	390	66	75			
	Mound Creek	31.1	9.3	9.8	8.7					3.3		135		3	546	548		402	85	61			
	New Years Creek (8 structures)												798		1009	1009		211		798			
	Caney Creek (6 structures)												240		340	340		100		240			
	Cow Creek	27.3	6	7.5	3					10.8		114		2	472	472		349	66	57			
	Varner Creek	18.8	7.7	4.1	7							50		2	316	316		219	40	57			
	Bessies and Iron Creek	57.9		57.9								147			1057	1057		735	106	216			
	SUBTOTAL	1733.6	137.7	362.6	386.6	.2	3.9	88.2	126.1	277.6	350.7	5791	1038	76	35383	33528	1855	24266	4071	7046		5	
Lower	San Patricio	72.1			19.7			38.5			13.9	105			585[2/]		585	416	71	98	XV	3	two 2-way
	Chiltipin	177.7			34.9			95.8			47	597			3323[2/]	498	2825	2361	403	559			
	SUBTOTAL	249.8			54.6			134.3			60.9	702			3908	498	3410	2777	474	657			
	BASIN TOTAL	2283.7	155.3	389.2	452.1	47.8	37.1	255.1	221.5	314.2	411.6	7276	1038	89	45074	38072	7002	30949	5202	8923		207	36 one-way; 21 2-way

1/ P - Perennial; I - Intermittent; E - Ephemeral
2/ Remaining acres are considered to be prairie or cropland.

Source: River Basin Staff, SCS

The salinity of bays and estuaries is influenced by the amount and rate of freshwater flow entering these systems. Due to the small amount of water being retained, the floodwater retarding structures would have little adverse effect on the overall amount of freshwater entering the bays and estuaries. The proposed channels; however, would cause a significant change in the natural rhythm of flow. This would disrupt critical functions such as breeding, feeding, migration, and defense against predators of those species dependent upon the bays and estuaries. The estuarine ecosystem is closely tuned to a certain salinity pattern that should be maintained by effective management of freshwater inflow. 1/

With these alterations of the stream course, a temporary increase in stream turbidity can be expected which would cause a reduction in light penetration, blanketing the bottom of streams, bays, and estuaries.

These modifications would result in the degradation or loss of the existing habitat which would cause a decrease in species diversity.

To supplant a portion of the natural stream habitat, 89 pools would be constructed in perennial streams at road crossings to provide an accessible fishery resource. These pools would have an approximate size of 1000 square yards with an average depth of four feet. Rock riprap will be placed within these pools for protection and to add diversity to the aquatic habitat. Side inlets would be designed with a pipe drop structure to reduce sediment deposition. Table 8-4 shows the approximate number of pools to be installed by watershed. This proposed EQ measure was the only alternative considered in replacing some of the habitat lost or modified in perennial streams.

Terrestrial species would be affected by reduction of valuable habitat adjacent to streams, and displacement by reservoirs. The loss of 38,000 acres of woody vegetation along the streams would reduce the number of inhabitants such as squirrels. It may also disrupt travel lanes for larger species in areas with little cover. Whether this loss of food and cover plants is significant can only be judged by its relative abundance in a specific area.

1/ Clark, John, 1974 Coastal Ecosystems, Ecological Considerations for Management of the Coastal Zone, the Conservation Foundation, Washington, D. C., pp. 178

The reduction of flood plain overflow would result in loss of valuable habitat for migrating waterfowl. To lessen the impact resulting from the removal of streamside vegetation, only one side of the stream would be affected. The removal of the present vegetation would be alternated from side to side in an attempt to leave the most desirable habitat for fish and wildlife, as well as to present an aesthetic appearance. The area which is cleared, with the exception of the channel side slope,would be revegetated to multi-purpose plants.

Precaution would be necessary in areas where wetlands occur; removal of floodwater or deepening the channel may result in the loss of these wetlands. According to the U. S. Fish and Wildlife Service's counties survey maps, at least 207 acres would be lost by project construction, Table 8-4. To preserve the remaining wetlands within these affected areas, water control gates (21 - two-way semi-automatic gates and 36 flap gates) will be installed. These gates would also allow an effective fish and wildlife management program to be carried out. Other wetland areas that were not identified by U. S. Fish and Wildlife Services survey may also be affected by project development. These areas will be identified during detailed planning.

Table 8-5 is an inventory of other important resources which occur in these watersheds. Whether these resources would be affected need to be determined during detailed planning.

These impacts relate a general overview as to the effects project implementation will have on the biological environment.

A detailed inventory will be made for each watershed to properly analyze the effects these projects would have on the aquatic and terrestial ecosystem. The extent of mitigating the loss of biological resources such as wetlands, riparian, and stream habitat will be determined during detailed watershed planning.

Economic

Resource development opportunities through USDA programs are based on assumptions drawn from all earlier sections of this study. Economic impacts resulting from implementation of the designated projects cannot be measured at scheduled time frames because anticipation of authorization and implementation is currently unfounded. However, measurement of impacts at projected intervals representing early action and long-range action for the same group of opportunities would be informative.

TABLE 8-5

USDA Program Opportunity Watersheds

Texas Coastal Basins

Feasible Watersheds				Bays Located Downstream From Watershed and Their Ecological Importance 1/			Threatened and Endangered Species					
No.	Watershed Name	County	Subarea	Downstream Bays	Oyster Reef	Important Nursery Areas	Flora 2/	Fauna 3/	Baldeagle Nesting Area 1/	Waterfowl Rookeries 1/	Archeological Sites 4/	Historical Sites 4/
17.	San Patricio	San Patricio	Lower	Nueces		Shrimp, finfish, blue crab	2				55	
20.	Chiltipin	San Patricio	Lower	Capano, Arenosa, Corpus Christi		Shrimp, finfish, blue crab	2				39	
32.	Seadrift-West Colomo	Calhoun	Middle	San Antonio	X	Shrimp, finfish, blue crab	2				8	
33.	Indianola	Calhoun	Middle	Lavaca, Matagorda, San Antonio, Espiritu Santo	X	Shrimp, finfish, blue crab	2				5	
34.	Garcitos Creek	Dewitt-Victoria-Jackson	Middle	Lavaca		Shrimp, finfish, blue crab	2, 3				4	
35.	Placedo Creek	Victoria-Calhoun	Middle	Lavaca		Shrimp, finfish, blue crab	2					
36.	Arenosa Creek	Victoria-Jackson-Lavaca	Middle	Lavaca		Shrimp, finfish, blue crab	2, 3				1	
39.	Lower Lavaca	Jackson	Middle	Lavaca		Shrimp, finfish, blue crab	2, 3				100	
41.	Lower Navidad	Lavaca-Jackson	Middle	Lavaca		Shrimp, finfish, blue crab	2, 3				9	
42.	Sandy Creek	Colorado-Lavaca-Jackson-Wharton	Middle	Lavaca		Shrimp, finfish, blue crab	2, 3				1	
44.	Mustang Creek	Colorado-Wharton-Jackson	Middle	Matagorda		Shrimp, finfish, blue crab	2, 3				13	
45.	Pin Oak Creek	Colorado-Wharton	Middle	Lavaca, Matagorda		Shrimp, finfish, blue crab	2, 3					
46.	Cox's & Keller's	Jackson-Calhoun	Middle	Carancahua	X	Shrimp, finfish, blue crab	2				22	
47.	Carancahua Creek	Wharton-Matagorda-Calhoun-Jackson	Middle	Tres Palacios		Shrimp, finfish, blue crab	2				3	
48.	Turtle Creek	Jackson-Matagorda	Middle	Tres Palacios		Shrimp, finfish, blue crab	2					
49.	Tres Palacios	Wharton-Matagorda	Middle	Tres Palacios		Shrimp, finfish, blue crab	2				1	
50.	West Tribs of Colorado	Matagorda	Middle	Gulf			2				7	
51.	Jones Creek	Wharton	Middle	Gulf			2					
52.	Blue Creek	Wharton-Matagorda	Middle	Gulf			2					
53.	East Tribs of Colorado	Colorado-Wharton	Middle	Gulf			2, 3				3	2
56.	West Tribs of San Bernard	Colorado-Wharton-Brazoria	Middle	Gulf			2, 3	Redwolf, Attwater Prairie Chicken			11	2
58.	Caney Creek	Wharton-Matagorda	Middle	Gulf			2				19	
59.	Live Oak Bayou	Matagorda	Middle	Gulf			2				9	
60.	East Tribs of San Bernard	Austin-Fort Bend-Brazoria	Middle	East Matagorda		Shrimp, finfish	2, 3	Redwolf			24	2
62.	Mound Creek	Fort Bend-Brazoria	Middle	Gulf			2	Redwolf			4	
65.	New Years Creek	Washington	Middle	Gulf			3, 4				9	1
66.	Caney Creek	Austin-Washington	Middle	Gulf			3, 4					1
71.	Cow Creek	Fort Bend-Brazoria	Middle	Gulf			2	Redwolf	X	X		
72.	Varner Creek	Brazoria	Middle	Gulf			2	Redwolf	X	X	3	3
75.	Bessie & Irons Creek	Waller-Fort Bend	Middle	Gulf			2, 3				12	
77.	Bastrop Bayou	Brazoria	Middle	Gulf			2	Redwolf			6	
94.	Old River	Liberty-Chambers	Upper	Trinity		Shrimp, finfish, blue crab	2	Redwolf			3	
98.	Turtle Bayou	Liberty-Chambers	Upper	Trinity		Shrimp, finfish, blue crab	2	Redwolf, River Otter			3	2
99.	Spindle Top Bayou & Others	Liberty-Jefferson-Galveston-Chambers	Upper	East Bay, Rollover Bay		Shrimp, finfish, blue crab	2	Redwolf, River Otter			33	1

1/ Data taken from Resources of the Texas Coastal Region.

2/ The numbers shown in this column refer to the Vegetative Regions of Texas which these watersheds occur in. Texas Organization of Endangered Species (TOES) Checklist of Threatened and Endangered Species (T & E), use these regions to delienate the boundaries to locate these plant species. The number of T & E plants that occur in these regions are as follows: Region 2 - 51 species; Region 3 - 35 species; Region 4 - 26 species. For specific information concerning the names of these species, use TOES Checklist.

3/ Data taken from Special Report on Fish and Wildlife Resources (Texas Coastal Basins River Basin Study). The black bear occurs in southeast Texas, so it may occur within Feasible Watersheds 94, 98, and 99. The mountain lion, baldeagle, and eskimo curlew (?) occur throughout the study ares. The ocelot and jaguarundi occur in the lower coast, so it may occur within the River Basin area.

4/ Data taken from Special Report on Archeology and Historical Resources.

Source: River Basin Staff, SCS

Essential conclusions of the impact analysis include: (1) Baseline agricultural production exhibited in Chapter 6 is satisfied without accelerated resource development, (2) Major land use patterns will not be changed by implementation of the 33 watershed projects. Production increases from development of resources, though beyond the national equilibrium approximated by baseline production, will not be limited by it, (3) Soil Conservation Service (SCS) watershed projects will increase crop yields, in addition, to nonaccelerated development projection yield on specified soil acreage. Operational efficiencies are an important part of the benefits expected from watershed development and, (4) Impacts of program opportunities, though likely to be reevaluated if not implemented in an early action concept, are exhibited for social values representing 2000 and 2020.

The 33 feasible watershed projects which make up a major portion of the USDA program opportunities are located in all three subareas of the Texas Coastal Basins. The 1,996,800 acres benefitted are shown by subarea and soil resource group distribution in Table 8-6. About 75 percent of the benefitted acreage is in SRG's 51 and 54, both prominent cropping soil groups in the study area. Reduction of flood risk and impaired damage on these agricultural soils is expected to enable food and fiber producers to achieve productivity efficiencies through operational cost reductions, risk reduction, and yield increase.

The assumption that major land use changes would not result from the watershed developments was based on the basin's ability to produce baseline amounts according to the linear program analysis in Chapter 6, and the location of watersheds in predominantly agricultural areas as opposed to "new land." New land may be brought into production in the project areas as a result of project measures if such lands are more efficient than other land conversions generated by the linear program.

However, in the Lower Subarea, watershed drainage development is expected to complement future irrigation acreage development which would likely include conversion of some dry cropping acreage as well as converted pastures and range. Within the scope of watershed development in the basin the productivity gains anticipated would be substantial and significantly advantageous to the operators and the area. However, across the wide variety of crops and forages from which benefits would be derived, national market effects would not be expected.

TABLE 8-6

Soil Resources Benefitted by
Soil Conservation Service Project Development

Texas Coastal Basins

Subarea	SRG 1/		Benefitted Acres
Upper		199,200	
	51		108,900
	54		79,500
	65		2,700
	66		8,100
Middle		1,677,900	
	51		669,600
	54		502,300
	56		22,100
	58		110,700
	65		215,700
	66		89,100
	67		53,100
	69		15,300
Lower		119,700	
	51		74,400
	54		34,600
	66		10,700
Total		1,996,800	

1/ See descriptions of soil resource groups in Chapter 5

Source: SCS, ERS

Projected annual benefits of USDA watershed project opportunities are shown in Table 8-7 in two categories, cost savings, and increased product value. Though additional output infers an enhancement effect the real effect is the realization of production anticipated by the farmers when they committed production inputs. Cost savings, limited to preharvest operational cost, would amount to $4.2 million in 2000, or if delayed, about $5.0 million in 2020. Variation between time periods reflects difference in the land base and projected

TABLE 8-7

Projected Annual Benefits of Watershed Development, Forest Production Improvement, and Outdoor Recreation Facility Program Opportunities, 2000 and 2020

Texas Coastal Basins

	2000		2020	
	Cost[1/] Savings	Additional[2/] Output	Cost[1/] Savings	Additional[2/] Output
	------------------$000------------------			
Watershed				
Upper Subarea	477	4,594	599	4,441
Middle Subarea	3,449	58,284	4,084	61,999
Lower Subarea	344	5,629	328	6,175
Total	4,240	68,507	5,011	72,615
Forest Production				
Upper Subarea	0	270	0	270
Outdoor Recreation				
Upper Subarea	0	1,200	0	1,200
Program Opportunities				
Total	4,240	69,977	5,011	74,085

1/ Production cost savings based on representative preharvest production costs of agricultural activities in the subareas.
2/ Benefitted output units based on SCS and FS estimates of resource group/crop benefit rates. Unit values based principally on Water Resources Council Price Standards, November 1975, and U. S. Forest Service price estimates.

Source: ERS

productivity. Additional production benefits due to average yield increases on productive land across all crops would be about $68.5 million in 2000 or $72.6 million in 2020. Over 80 percent of benefits would accrue in the Middle Subarea where the majority of benefitted acres are located as well as the largest acreage of cropland. Cost savings due to drainage projects include both labor and non-labor inputs. By the nature of this computed benefit, the producer is the direct beneficiary of the savings because his operational mode includes a reduced risk of wetness. Inherent risks include lost plantings, times over a field with labor, chemicals and equipment, and lost crops. The producer's direct loss is not always a direct loss to supplies and labor because these inputs have already been invested. The community loss essentially begins when the producer is unable to harvest or experiences reduced profits which would eventually be spent in the local economy. Value of increased forest production in the Upper Subarea through U. S. Forest Service programs is $270 thousand. The additional production is expected to be effective by 2000 and be a continuous advantage to production. Outdoor recreation facility development by the U. S. Forest Service anticipates a participation value of $1.2 million.

About 24 percent of these savings would be household income inputs. In the case of operational cost savings, an undetermined portion would be reduced labor payments, while the remainder would be attributed to potential flood and wetness loss recovery as a result of project development. Based on coefficients for specified agricultural output groups in the Texas Input-Output Analysis, direct income changes and indirect and induced income changes were computed to reflect these effects from production or facility increases. From the combined production increases of program opportunities, household incomes could be expected to be increased $32.8 million in 2000 or $35.3 million in 2020. About $45.7 million more household income would be generated in other sectors through indirect and induced activity in 2000 or $48.0 million by 2020. The subarea distribution of total household income change is shown in Table 8-8.

Outdoor recreation income generation may or may not be an income multiplying agent, depending upon what substitutes are present for the expenditure of these funds. Because this sector is a nonbasic industry, the potential increase may be considered an inter-or intra-industry transfer of output within the State economy, but an advantage to the area. Distribution among specified income groups is undetermined. Much will depend on the proprietorship structures at the time of development. Though the Lower Subarea, has experienced the least per capita income, the Middle Subarea would benefit by the largest amount of

Table 8-8

Household Income Benefits of Program Opportunities, 2000 and 2020

Texas Coastal Basins

Opportunities/Changes	Household Income 1/	
	2000	2020
	--------$000--------	
Watershed Projects		
Direct Household Income Change	32,019	34,531
Upper Subarea	2,235	2,261
Middle Subarea	26,894	29,099
Lower Subarea	2,890	3,171
Indirect and Induced Household Income Change	44,983	47,212
Upper Subarea	3,035	2,823
Middle Subarea	38,280	40,714
Lower Subarea	3,668	3,675
Outdoor Recreation Facility		
Direct Household Income Change		
Upper Subarea	681	681
Indirect and Induced Household Income Change		
Upper Subarea	642	642
Forest Production Development		
Direct Household Income Change		
Upper Subarea	854	854
Indirect and Induced Household Income Change		
Upper Subarea	1,795	1,795
Total Household Income Benefits		
Direct	33,554	36,066
Indirect and Induced	47,420	49,649

1/ Based on household income change resulting from output change of specified products and product groups in Texas Input-Output Analysis.

Source: ERS

economic activity increase derived from program opportunities. This economic activity would guarantee development of employment and income factors, but would not guarantee a specified distribution between income groups. Employment benefits resulting from the program opportunities would be positive but conjectural in respect to the future employment mix and substitution of capital for labor. The principal output gain is through production efficiencies with no anticipated new land production. Upon this basis, employment gains for output resulting from program opportunity are estimated on household income to indirect and induced activities. Based on OBERS per capita income and employment rate projections, year 2000 estimates for gains in the basin are 449 man-years in the Upper Subarea, 1,664 man-years in the Middle Subarea, and 127 man-years in the Lower Subareas.

Erosion and Sedimentation

Table 8-9 shows the total amounts of erosion and sedimentation expected under USDA program opportunity development conditions. These quantities were modified from Chapter 6 to reflect the impact of the installation of the 33 potentially feasible PL-566, watershed projects by the year 2000.

Reductions in tons delivered should occur due to the accelerated land treatment program which will accompany the installation of the watershed projects.

A slight decrease in scour damages should occur as a result of project installation. Overbank deposition on the flood plain will be reduced slightly as a result of the installation of floodwater retarding structures in two watersheds in the Middle Subarea. Annual sediment delivered to the bays and estuaries is estimated to be reduced by 81,400 tons by the year 2000 and by 177,400 tons by the year 2020 should USDA program opportunities be realized.

Effectiveness to Meet Objectives and Component Needs

Water and land resource problems of the basin resulted in study concerns as described in Chapter 3. These study concerns were then used to identify the specific components of the major objectives.

Component needs were identified to meet these objectives in Chapter 7. These needs were quantified for each objective and

TABLE 8-9

Erosion and Sedimentation Summary
Total Amounts with Plan Development

Texas Coastal Basins

	Upper Subarea			Middle Subarea			Lower Subarea			Basin Totals		
	Current	2000	2020	Current	2000	2020	Current	2000	2020	Current	2000	2020
Del. sheet tons	1,307,400	1,484,400	1,438,100	2,459,300	2,481,200	2,380,900	2,903,700	2,838,900	2,788,200	6,670,400	6,804,500	6,607,200
Del. gully tons	268,200	228,000	201,200	207,200	176,100	155,400	50,900	43,300	38,200	526,300	447,400	394,800
Del. streamb. tons	785,900	736,800	705,300	308,300	289,000	276,700	92,600	86,800	83,100	1,186,800	1,112,600	1,065,100
Del. roadside tons	380,300	332,800	313,700	81,000	70,900	66,800	46,300	40,500	38,200	507,600	444,200	418,700
Del. shoreline tons	193,700	181,600	162,200	483,300	453,100	404,800	344,000	322,500	288,100	1,021,000	957,200	855,100
Scour acres ann.	1,000	700	800	3,000	2,800	2,900	7,100	6,800	6,800	11,100	10,300	10,500
Land lost-gully ac.	25	19	16	24	18	15	19	14	12	68	51	44
Land lost-streamb. ac.	62	58	56	38	36	43	33	31	30	133	125	129
Land lost-shore. ac.	39	37	33	55	52	46	15	14	13	109	103	92
Overbank deposition ac.	19,400	17,000	14,100	13,100	10,800	9,500	6,900	6,000	5,000	39,400	33,800	28,600
Sed. to bays & est. tons	2,991,500	3,020,200	2,874,000	19,676,800	19,733,800	18,877,400	4,491,800	4,354,100	4,230,400	27,160,100	26,897,000	25,931,800

Source: River Basin Staff, SCS

are obtainable within the limits of the basin resources. There may be some problems relating to financial matters and expansion of some programs. The USDA programs would meet the objectives, as outlined, if the program elements are installed. The overall effectiveness to meet objectives depends on the effectiveness of the USDA programs to meet the component needs.

The ability of the USDA program elements to meet the component needs for both objectives is portrayed by data presented in Table 8-10.

IMPLEMENTATION PROGRAMS

General

The program is a mix of elements from the major objectives with implementation opportunities for individual plan elements through a variety of Federal, State, and local programs. The priorities and schedule for installation of various elements will depend upon the willingness of local people to undertake organizational efforts necessary for project action. Technical and financial assistance for most elements can be obtained through existing programs of local, State, and Federal agencies. Some elements can only be installed with significant increase in levels of funding or additional local, State, or Federal legislation, and program authorities may be needed. The kind and amount of measures that can be implemented under USDA programs and other programs are identified in Table 8-11.

Floodwater Damage Reduction

The programs to implement USDA program opportunity elements to reduce flood damages are the upstream watershed program (Public Law 566) and the Resource Conservation and Development program (Public Law 87-703). Potential watershed projects are identified on Plate 8-1. The Soil Conservation Service has primary responsibility for administering Public Law 566 and the RC&D programs. Local sponsorship and public participation is required before planning can be initiated. The Farmers Home Administration (FmHA) can make grants on low interest and deferred payment loans to sponsoring organizations to assist in implementing flood prevention projects. Loans are used to finance the local cost-sharing items as required by individual projects.

TABLE 8-10

USDA Program Opportunity Effectiveness

Texas Coastal Basins

Component Needs	Units	Quantities Needed 2000	Quantities Needed 2020	USDA Programs 2000 Provides	USDA Programs 2000 Remaining 1/	USDA Programs 2020 Provides	USDA Programs 2020 Remaining 1/
Flood Damage Reduction							
Agriculture	Thousand Acres	3,780	3,552	1,709	2,071	0	3,552
	Thousand Dollars	29,548	16,762	16,541	13,007	8,344	8,418
Urban	Thousand Acres	390	385	0	390	0	385
	Thousand Dollars	60,239	96,744	0	60,239	0	96,744
Recreation 2/	Thousand Activity Days	612,000 2/	1,270,000 2/	239 3/	611,761	0	1,270,000
Timber Production	Thousand Cubic Feet	15,000	0	15,000	0	0	0
Erosion & Sedimentation Damage Reduction							
Sheet	Thousand Tons	2,102	3,411	81	2,021	177	3,234
Overbank Deposition	Thousand Acres	14.7	28.6	0.7	14	0	28.6
Bays & Estuaries	Thousand Tons	6,630	12,593	71	6,559	177	12,416
Gully	Acres	16	44	0	16	0	44
Streambank	Acres	59	120	0	59	0	120
Shoreline	Acres	47	92	0	47	0	92
Scour	Thousand Acres	5.2	10.5	0.5	4.7	0	10.5

1/ Some remaining needs will be satisfied by other programs and plans.
2/ Based on Texas Outdoor Recreation Plan-TPWD-1976
3/ Based on National Forest unit plan

Source: FS, SCS

TABLE 8-11

Elements and Program Means for Implementation

Texas Coastal Basins

Elements	U. S. Department of Agriculture Programs	Other than USDA Programs
Resource Management Systems	ACP, PL-46, PL-566, RC&D	
Flood Damage Reduction		
Channel Modification	ACP, PL-46, PL-566, RC&D	National Weather Service, USGS, COE, HUD-FIA, FmHA
Floodwater Retarding Structures	PL-566, RC&D	National Weather Service, USGS, COE, HUD-FIA, FmHA
Non-Structural	PL-566, RC&D	National Weather Service, USGS, COE, HUD-FIA, FmHA
Forest Production	USFS - FPU, RC&D, NFS, CFM, GFA, CM-4, FIP	Texas Forest Service
Irrigation Water 1/		Bureau of Reclamation, State River Authority, Corps of Engineers
Erosion & Sedimentation Damage Reduction		
Sheet	ACP, PL-46	
Overbank Deposition	ACP, PL-46, PL-566, RC&D	PL 92-500
Gully	ACP, PL-46, PL-566, RC&D	PL 92-500
Streambank	ACP, PL-46, PL-566, RC&D	PL 92-500
Roadside	ACP, PL-46, PL-566, RC&D	PL 92-500
Site Preservation		
Archeological		USDI - NPS, Texas Archeological Society
Historical		USDI - NPS, Texas Historical Commission
Increased Recreation		
Parks		USDI, NPS
Camping	RC&D, FS	USDI, TPWD, NPS
Picnicking	RC&D, FS	USDI, TPWD
Playground	RC&D	TPWD
Trails (Combined)	RC&D, FS	TPWD, NPS
Fishing Piers	RC&D	USDI
Watersports	PL-566	USDI
Boat Ramps	RC&D, FS	USDI, TPWD
Fish and Wildlife Habitat Improvement & Increase Water Impoundments	PL-566, ACP, RC&D, PL-46	USDI, Dingell-Johnson Act, Duck Stamp Act, Pittman-Roberson Act, TPWD

1/ State Water Plan

Source: FS, SCS

When remedial measures are undertaken, first consideration should be given to non-structural measures such as land treatment to reduce storm runoff and changed land use in the flood plain to reduce monetary damages. An increase in funding is needed so that technical assistance can be provided by SCS through Public Law 46 to identify those areas most adaptable to this means.

The program measures for floodwater damage reduction are considered applicable for agricultural drainage on flatlands, also. Floodwater channels are needed in many cases to provide suitable outlets for drainage systems.

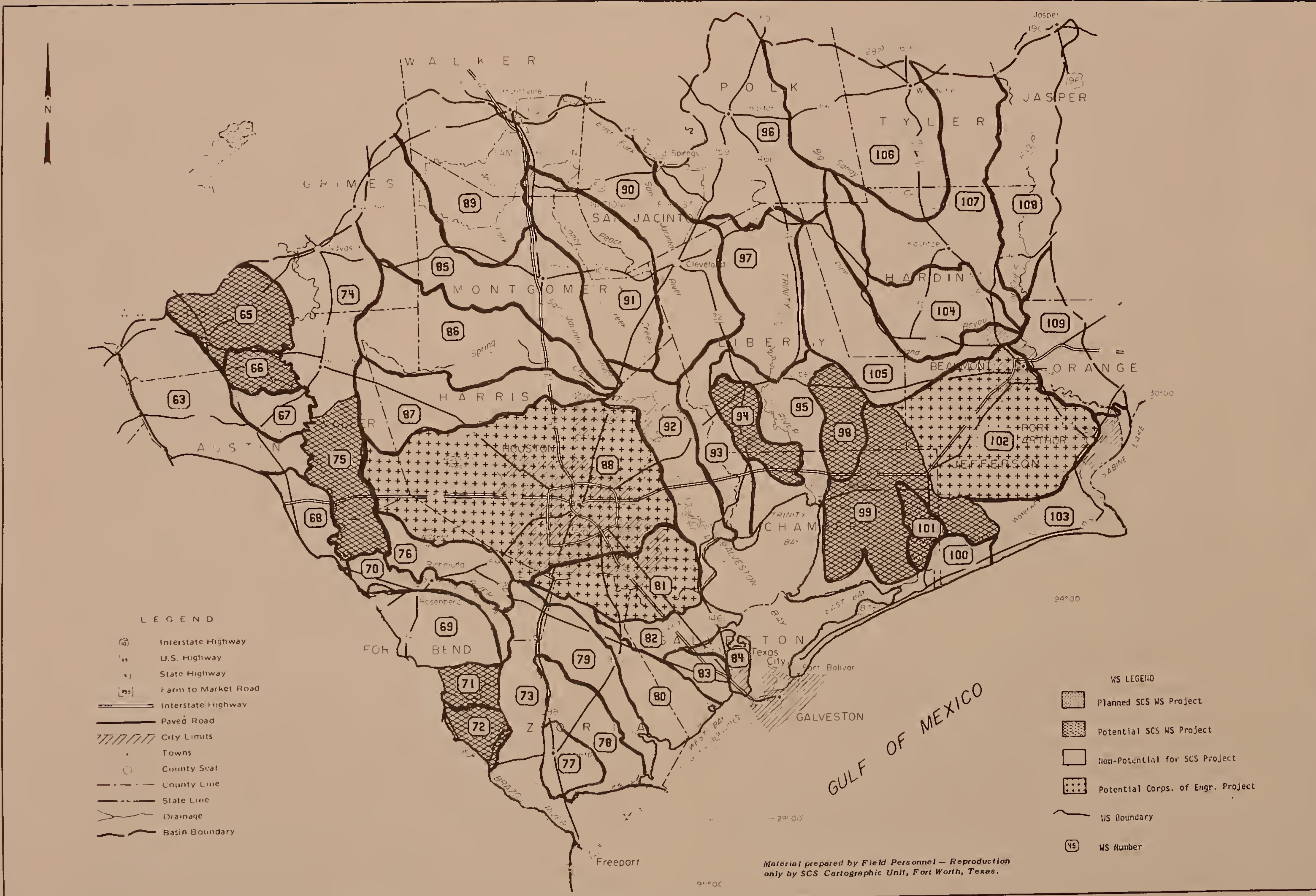
The Public Law 46 program of the Soil Conservation Service provides technical assistance through the local soil and water conservation districts for planning and installing conservation treatment measures. An acceleration of this technical assistance is available for watersheds planned under Public Law 566 and for areas where project measures are planned in the RC&D project areas. A portion of the drainage measures will be installed by individual landowners with no assistance from outside sources.

The Soil Conservation Service participates in flood hazard analyses to identify flood plains in urban and adjacent areas subject to future development. Requests for this assistance can be directed through the appropriate soil and water conservation district. The purpose of these studies is to provide data to State and local governments in their flood plain management programs.

Resource Management Systems

The USDA programs include providing technical assistance for all measures and cost-sharing on other measures. Rapid acceleration of services will be required in order to achieve the level of treatment needed. Some acceleration will occur when the suggested watersheds are planned and installed under PL-566; acceleration will also occur as project measures are installed in RC&D project areas. The Soil Conservation Service and U. S. Forest Service have the major responsibilities for planning and installing these projects. Local landowners or sponsors are responsible for operating and maintaining the installed measures.

The installation of resource management systems which is not in authorized watersheds or RC&D project areas is limited to technical assistance provided to local soil and water conservation districts (Public Law 46). In counties where the local ASCS committee has programs that cover these measures, financial assistance (cost-sharing) is available. The U. S. Forest Service



TEXAS COASTAL BASINS

	WATERSHED	ACRES	
63	Mill Creek	248,500	
65	New Years Creek	143,500	
66	Caney Creek	45,600	
67	Piney Creek	54,200	
68	Allens Creek	43,100	
69	Big Creek	145,700	
70	Southwest Brazos Laterals	53,300	
71	Cow Creek	43,200	
72	Varner Creek	46,700	
73	Lower Oyster	206,700	
74	Upper Brazos River	218,400	
75	Bessies and Irons Creek	130,800	
Subtotal Brazos River Basin			1,417,600
76	Oyster Creek	96,600	
77	Bastrop Bayou	56,700	
78	Austin-Flores Bayous	122,800	
79	Chocolate Bayou	123,800	
80	New and Hall's Bayou	121,300	
81	Clear Creek	160,000	
82	Dickinson Bayou	72,700	
83	Highland Bayou	41,200	
84	Moses Bayou	30,000	
Subtotal San Jacinto-Brazos River Basin			825,100
85	Lower W. Fork San Jacinto	379,200	
86	Spring Creek	286,900	
87	Cypress Creek	208,100	
88	Buffalo Bayou	661,800	
89	West Fork San Jacinto	286,900	
90	East Fork San Jacinto	387,200	
91	Caney Creek (Montgomery)	241,300	
92	Lower San Jacinto	173,800	
Subtotal San Jacinto River Basin			2,625,200
93	Cedar Bayou	116,000	
Subtotal Trinity-San Jacinto River Basin			116,000
94	Old River	71,800	
95	Lower Trinity	167,700	
96	Upper Trinity	371,400	
97	Middle Trinity	200,100	
98	Turtle Bayou	83,500	
Subtotal Trinity River Basin			894,500
99	Spindletop Bayou and Others	223,300	
100	Spindletop Marsh	154,600	
101	East Bay Bayou	36,000	
102	Taylors Bayou	375,000	
103	Salt Bayou	115,200	
Subtotal Neches-Trinity River Basin			904,100
104	Eastern Pine Island Bayou	209,400	
105	Western Pine Island Bayou	247,800	
106	Upper Village Creek	412,000	
107	Lower Village Creek	329,400	
108	Upper Neches River	256,200	
109	Lower Neches River	154,400	
Subtotal Neches River Basin			1,609,200

Plate 8-1

WATERSHEDS
TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

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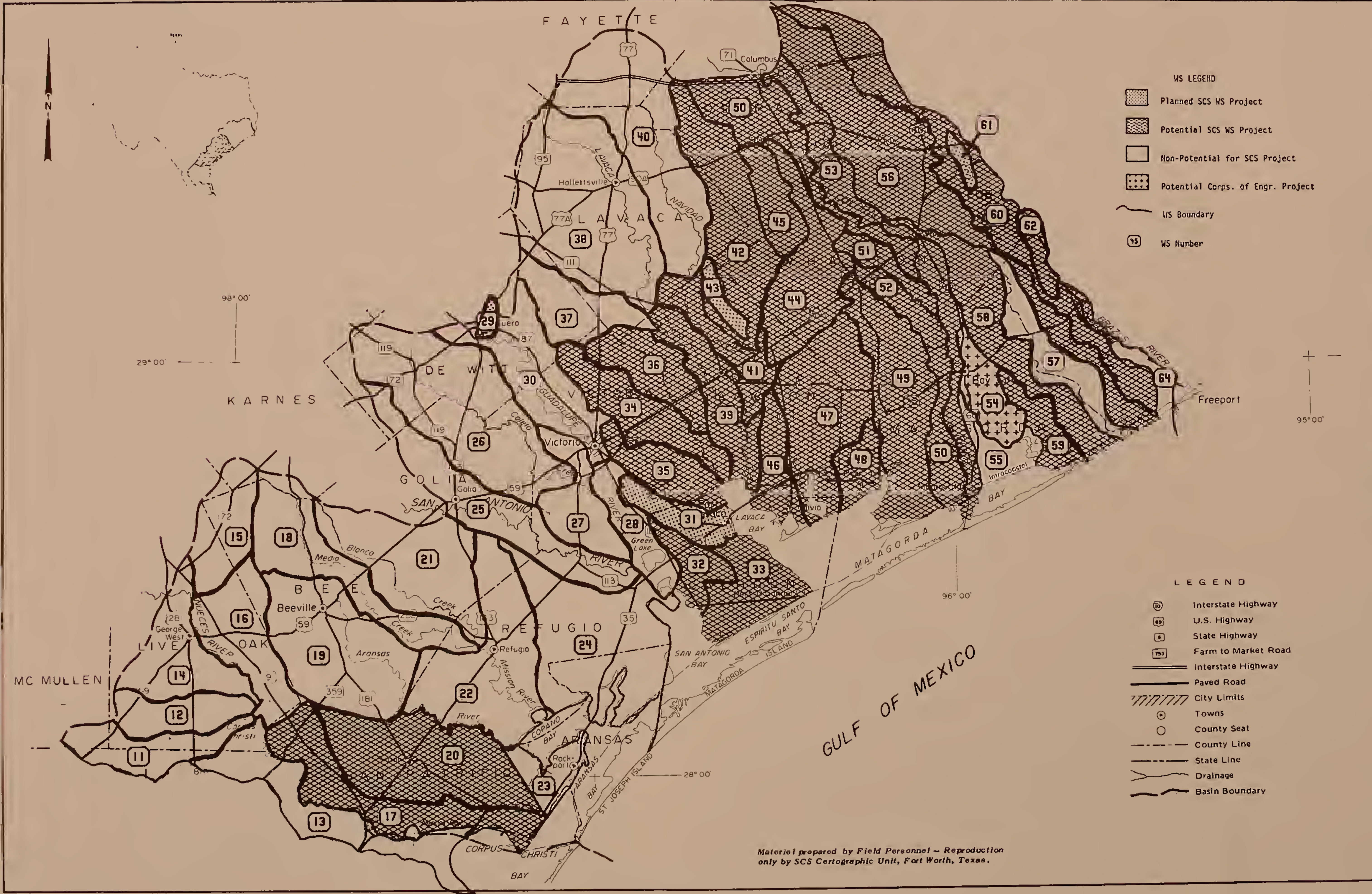

TEXAS COASTAL BASINS

WATERSHED		ACRES	
11	Lagarto Creek	112,000	
12	Ramirena Creek	94,000	
13	Lower Nueces Laterals	152,800	
14	W. Laterals of Nueces River	143,500	
15	Sulphur Creek	109,200	
16	E. Laterals of Nueces River	153,600	
17	San Patricio	194,200	
Subtotal Nueces River Basin			959,300
18	Medio Creek	216,200	
19	Upper Aransas River	280,900	
20	Chiltipin Creek	245,900	
21	Blanco Creek	229,100	
22	Woodsboro-Bonnie View	276,900	
23	S. W. Copano Bay Laterals	53,400	
24	Austwell-Tivoli-Refugio	295,700	
Subtotal San Antonio-Nueces Basin			1,598,100
25	San Antonio River	216,200	
Subtotal San Antonio River Basin			216,200
26	Coleto Creek	334,100	
27	Lower Coleto Creek	105,900	
28	Green Lake	78,800	
29	North Cuero	12,600	
30	Guadalupe	198,100	
Subtotal Guadalupe River Basin			729,500
31	Choc.-Little Choc.-Lynns	43,200	
32	Seadrift-West Coloma	60,400	
33	Indianola	119,800	
34	Garcitas Creek	129,700	
35	Placedo Creek	84,500	
36	Arenosa Creek	113,900	
Subtotal Lavaca-Guadalupe River Basin			551,500
37	Chicolete Creek	114,400	
38	Upper Lavaca	339,100	
39	Lower Lavaca	129,500	
40	Upper Navidad	283,900	
41	Lower Navidad River	85,600	
42	Sandy Creek	204,800	
43	Brushy Creek	20,500	
44	Mustang Creek	179,800	
45	Pin Oak Creek	76,700	
Subtotal Lavaca River Basin			1,434,500
46	Coxs and Kellers	68,800	
47	Carancahua Creek	217,000	
48	Turtle Creek	32,600	
49	Tres Palacios	233,900	
Subtotal Colorado-Lavaca River Basin			552,300
50	W. Tribs. of the Colorado	228,200	
51	Jones Creek (Wharton)	45,900	
52	Blue Creek	49,200	
53	E. Tribs. of the Colorado	168,800	
Subtotal Colorado River Basin			492,100
54	Peyton Creek	66,600	
55	E. Matagorda Bay Laterals	56,600	
56	W. Tribs. of San Bernard	378,600	
57	Cedar Lake Creek	109,600	
58	Caney Creek	168,400	
59	Live Oak Bayou	60,700	
60	E. Tribs. of San Bernard	245,600	
61	Turkey Creek	18,900	
62	Mound Creek	23,700	
Subtotal Brazos-Colorado River Basin			1,129,100
64	Jones Creek (Brazoria)	37,900	
Subtotal Brazos River Basin			37,900

Plate 8-1

WATERSHEDS
TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

APPROXIMATE SCALE
0 10 20 30 40 MILES

Compiled from USGS Base Map of Texas
Lambert Conformal Conic Projection

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TEXAS COASTAL BASINS

NUMBER	WATERSHED	ACRES	
1	Laguna Madre Laterals	1,400,500	
2	Palo Blanco	882,800	
3	Los Olmos Creek	403,900	
4	Jaboncillos Creek	708,500	
5	San Diego Rosita	222,400	
6	Chiltipin-San Fernando	215,700	
7	Agua Dulce Laterals	92,800	
8	Lower Agua Dulce Laterals	269,000	
9	Agua Dulce Creek	228,700	
10	Oso Creek	181,400	
Subtotal Nueces-Rio Grande Basin			4,605,700

L E G E N D

- Interstate Highway
- U.S. Highway
- State Highway
- Farm to Market Road
- Interstate Highway
- Paved Road
- City Limits
- Towns
- County Seat
- County Line
- State Line
- Drainage
- Basin Boundary

WS LEGEND

- Planned SCS WS Project
- Potential SCS WS Project
- Non-Potential for SCS Project
- Potential Corps. of Engr. Project
- WS Boundary
- WS Number

Plate 8-1

WATERSHEDS
TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

APPROXIMATE SCALE

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treats critical areas on National Forest lands under several programs which allow for complete management and conservation treatment on those lands. Additional authorization is needed to allow and/or induce accelerated installation of protective measures. On-going programs have historically been funded at a low level of cost-sharing (incentive) which has had the effect of producing a low level of participation on the part of private landowners.

Increased Forest Production

The U. S. Forest Service, in cooperation with the Texas Forest Service, can provide the accelerated technical assistance for the training necessary to increase forest utilization through the Forest Products Utilization (FPU) program authorized by the Cooperative Forest Management Act of 1950. Acceleration of this program will provide the skill and knowledge necessary to achieve the goals of the program.

Technical and financial assistance needed to reach stated goals in reforestation and improvement cuttings is available through acceleration of such programs as: Cooperative Forest Management (CFM), General Forestry Assistance (GFA), Cooperative Tree Seeding (CM-4), and Forestry Incentives Program (FIP) administered by ASCS and State Forest Service. In addition, supplemental funding for both increased forest utilization and accelerated forest management can be provided through Resource Conservation and Development (RC&D) programs.

Recreation

Recreation proposals could be implemented through a combination of Federal assistance programs, State appropriation, and local funding. Local cost-sharing is usually involved; consequently, the success of the recreation measures depend largely upon the financial ability of the public to accept this type of obligation.

The Outdoor Recreation-Acquisition and Development Program administered by the Bureau of Outdoor Recreation, U. S. Department of the Interior, is another Federal source of recreation funds. Grants are made to State and county agencies for purchase and development of outdoor recreation areas. These funds could be used to develop county parks and city parks emphasizing outdoor recreation.

The Forest Service, USDA, maintains hiking trails and campsites in all National Forest areas. Funds are appropriated through the

Forest Service for developments in the Sam Houston National Forest.

Erosion and Sedimentation Damage Reduction

Programs for reduction of sedimentation are primarily erosion control measures. Erosion damage reduction will be accomplished on cropland, pastureland, forest land, rangeland, and other lands by applying the best management practices that are tailored to soil groups in use. Programs of the USDA provide technical assistance on a limited basis.

On-going programs are now provided through organized soil and water conservation districts. Public Law 46 provides for furnishing technical assistance in treating any land within the districts. Acceleration of services occurs when a watershed is planned under Public Law 566 or a project measure is planned in an RC&D project area.

Plans to control non-point sources of pollution, including sedimentation, are being prepared for the Environmental Protection Agency under Section 208 of the Water Pollution Control Act Amendment of 1972. These plans may provide the needed new programs to accomplish accelerated treatment.

SUMMARY OF ACCOUNT

As required by the Principles and Standards, the beneficial and adverse effects of the suggested early action plan are displayed in Table 8-12. The data are presented for each subarea and for the basin.

TABLE 8-12

Program Opportunities
Economic Development Account

Texas Coastal Basins

(2000)

Components	Measure of Effect Subareas Upper	Middle	Lower	Basin Total
Beneficial Effects	-----Average Annual $000-----			
A. Value to users of increased productivity				
1. Flood water damage reduction	1,350	13,077	1,044	15,471
2. Improved agricultural water management	1,350	12,734	1,044	15,128
3. Forest production development	270	0	0	270
4. Outdoor Recreation facility	1,200	0	0	1,200
5. Utilization of labor resources in project construction	80	507	43	630
Total direct beneficial effects	4,250	26,318	2,131	32,699
6. Value of output to users indirectly associated	2,534	16,950	1,376	20,860
Total beneficial effects	6,784	43,263	3,507	53,559
B. Employment increases due to increased output	-----Average Annual Man Years-----			
1. Floodwater damage reduction	85	782	58	925
2. Improved agricultural water management	84	782	59	925
3. Forest production development	14	0	0	14
4. Outdoor recreation facility	55	0	0	55
5. Project Construction	16	100	10	126
Total	254	1,664	127	2,045
Adverse Effects				
A. Value of resources required	-----Average Annual $000-----			
1. Floodwater channels and retarding structures				
a. Project installation and administration	1,574	9,910	958	12,442
b. O M & R	449	2,164	195	2,808
Total	2,023	12,074	1,153	15,250
2. Forest production development program	118	0	0	118
3. Outdoor recreation facility installation and administration	100	0	0	100
Total adverse	2,241	12,074	1,153	15,468
Net beneficial effects	4,543	31,194	2,354	38,091

TABLE 8-12 (cont'd)

Social Well-Being Account

Texas Coastal Basins

Components	Beneficial and Adverse Effects
1. Personal income increase	1. Increased operator efficiencies will be beneficial to a broad base of farming enterprises. 2. Operational cost savings and increased yields will assist rural farm families to achieve OBERS projected per capita income levels.
2. Employment	1. Income and employment increases anticipate both increased employment of underemployed and unemployed labor resources at minimum to medium scale. 2. Employment of persons directly and indirectly associated with program opportunities affects a broad range of agribusiness activities.
3. Health and safety	1. Increased use of natural resources at potential levels and at higher and better uses. 2. Increased food and fiber output, economic stability and potential for semi-skilled employment. 3. Increased safety of outdoor leisure in planned, natural environment.
4. Rural opportunities	1. Stabilizes rural economy and rural living in areas of productivity improvement. 2. Increases opportunity for profit in the rural areas.

TABLE 8-12 (cont'd)

Environmental Quality Account

Texas Coastal Basins

Components	Measures of Effects	Unit	Upper	Middle	Lower	Total
Beneficial and adverse effects:						
A. Areas of natural beauty	1. Create water surface	Acres	0	1,054	0	1,054
	2. Create pools within channels	Number	13	76	0	89
	3. Convert natural channel to man-made	Miles	55.1	886.9	54.6	996.6
	4. Inundate and alter land use by floodwater retarding structures	Acres	0	1,349	0	1,349
	a. Pasture	Acres	0	732	0	732
	b. Cropland	Acres	0	465	0	465
	c. Rangeland	Acres	0	152	0	152
	5. Plant channel right of way to multipurpose plants	Acres	3,906	24,266	2,777	30,949
	6. Plant channel right of way to single-purpose plants	Acres	657	4,071	474	5,202
	7. Eliminate wetlands	Acres	199	5	3	207
	8. Eliminate woody riparian vegetation	Acres	4,046	33,528	498	38,072
	9. Eliminate marsh riparian vegetation	Acres	1,737	1,855	508	4,100
	10. Convert land to stream channel	Acres	1,220	7,046	557	8,923
	11. Modify natural perennial stream channel	Miles	17.6	137.7	0	155.3
B. Quality considerations of water and land resources	1. Reduce sheet erosion	Acres	378,600	3,511,300	440,100	4,330,000
	2. Reduce scour damage on flood plains	Acres	200	150	100	450
	3. Reduce outbank deposition on flood plains	Acres	0	700	0	700
	4. Reduce sediment delivered to bays and estuaries	Tons	9,500	155,700	12,200	177,400
C. Biological resources and selected ecosystems	1. Improve wildlife habitat for ground nesting birds by reduction in flood frequency from flood water retarding structures	Acres	0	13,600	0	13,600
	2. Create additional surface acres of water (floodwater retarding structures)	Acres	0	1,054	0	1,054
	3. Inundate terrestrial habitat	Acres	0	1,054	0	1,054
	4. Loss of wetland habitat	Acres	199	5	3	207
	5. Protect remaining wetlands with water control gates	Number	52	3	2	57
	6. Alter natural perennial streams	Miles	17.6	137.7	0	155.3
	7. Create pools for fish	Number	13	76	0	89
	8. Loss of woody riparian habitat	Acres	4,046	33,528	498	38,072
	9. Loss of marsh riparian habitat	Acres	1,737	1,855	508	4,100
	10. Convert riparian habitat to channel	Acres	1,220	7,046	657	8,923
	11. Reseed disturbed area to multipurpose vegetation	Acres	3,906	24,266	2,777	30,949
D. Archeological resources	1. Preserve and protect archeological sites	Number	1,450	911	317	2,578
	2. Preserve and protect historical sites	Number	134	150	35	319
	3. Inventory additional archeological sites	Number	30	176	25	231
	4. Inventory additional historical sites	Number	80	67	18	165
E. Irreversible or irretrievable commitments	1. Conversion of agricultural land to dams, spillways, and sediment pools	Acres	0	1,054	0	1,054
	2. Conversion of land to stream channels	Acres	1,283	7,046	657	8,986
	3. Materials, labor, equipment, fuel, and capital used in construction, operation, and maintenance					

Source: SCS, ERS, FS

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